air

PARTICULATE MATTER AND OZONE ASSESSMENT FOR ALBERTA: 2001 – 2007

Alberta Environment

PARTICULATE MATTER AND OZONE ASSESSMENT FOR ALBERTA: 2001 – 2007

Prepared by
Air Policy Section
Environmental Assurance Division
Alberta Environment

April 6, 2009

ISBN No. 978-0-7785-8126-0 (Printed)
ISBN No. 978-0-7785-8127-7 (On-line)
Web Site: http://www.environment.alberta.ca/

Any comments, questions, or suggestions regarding the content of this document may be directed to:

Air Policy Section
Alberta Environment
11th floor, Baker Centre
10025 – 106th Street
Edmonton, Alberta T5J 1G4
Fax: (780) 644-8946

Additional copies of this document may be obtained by contacting:

Information Centre
Alberta Environment
Main Floor, Oxbridge Place
9820 – 106th Street
Edmonton, Alberta T5K 2J6
Phone: (780) 427-2700
Fax: (780) 422-4086
Email: env.infocent@gov.ab.ca

OVERVIEW

Alberta Environment has completed five annual assessments of particulate matter (PM) and ozone data as promised under the *Clean Air Strategic Alliance (CASA) Particulate Matter and Ozone Management Framework*. These assessments compare outdoor levels of fine particulate matter ($PM_{2.5}$) and ozone data to action triggers defined by the CASA Framework. Action levels have been assigned to the Edmonton and Calgary Census Metropolitan Areas and individual air monitoring stations in Alberta based on the procedure defined by the Canada Wide Standards (CWS) for particulate matter and ozone and the CASA Framework. The annual assessments have been conducted for the following time periods:

- 2001 to 2003
- 2002 to 2004
- 2003 to 2005
- 2004 to 2006
- 2005 to 2007

The results of all five annual assessments show that $PM_{2.5}$ and ozone levels at all monitoring stations were lower than the CWS exceedance trigger based on data from 2001 to 2007 after backing out or removing episodes that were primarily caused by natural, background or trans-boundary influences. However, the assessment results have shown that ozone levels in some areas of the province are approaching CWS levels and therefore air quality management plans need to be developed.

The Edmonton and Calgary Census Metropolitan Areas (CMAs) were assigned to the *Management Plan* action level for ozone based on the initial 2001-2003 assessment. Also, the Edmonton Northwest, Edmonton East, Calgary Northwest, Red Deer, Caroline, Fort Saskatchewan, Tomahawk, Carrot Creek and Violet Grove stations were assigned to the *Management Plan* action level for ozone based on the 2001-2003 assessment. The Genesee station was assigned to the *Management Plan* action level for ozone based on the 2003-2005 assessment and the Edmonton South station was assigned to the *Management Plan* action level for ozone based on the 2005-2007 assessment.

In November of 2006, Alberta Environment (AENV) informed stakeholders in the Edmonton, Red Deer and Calgary areas of the need to develop air quality management plans. The goal of the management plans is to ensure that ozone smog levels remain lower than CWS limits. The affected airsheds have completed air management plans and these were submitted to AENV by December 31, 2008. Management plans have been developed for:

- The Capital airshed (Edmonton area) by the Alberta Capital Airshed Alliance, Fort Air Partnership and West Central Airshed Society,
- The Parkland airshed (Red Deer area) by the Parkland Airshed Management Zone; and
- The Calgary airshed by the Calgary Region Airshed Zone.

Following the initial 2001-2003 assessment, meteorological conditions (e.g. cooler summers) have led to lower peak ozone concentrations and subsequently ozone values have fallen below the *Management Plan* action level trigger at some monitoring stations. However, the *CASA Particulate Matter and Ozone Implementation Project Team* agreed by consensus that the highest assigned action level will remain to avoid stations and CMAs from moving in and out of action level categories.

In Alberta, ozone and $PM_{2.5}$ levels are driven by meteorological conditions combined with the presence of anthropogenic and natural influences. The highest frequency of occurrence of ozone smog events was in the summer of 2002 when there was a long stretch of hot summer days with maximum daily temperatures greater than 30°C throughout most of central Alberta. $PM_{2.5}$ events were most prevalent in the summer and early fall of 2003 due to forest fire events originating from within and outside of Alberta. Stagnant weather conditions in the fall and winter, along with the presence of anthropogenic pollutants, also lead to elevated $PM_{2.5}$ levels.

There is evidence of an 'ozone belt' comprising the area around Edmonton, the Fort Saskatchewan airshed and the West Central airshed. This area of the province consistently has the highest frequency of ozone events based on the five assessment periods. This region has numerous sources of ozone precursors including the power plants in the west, vehicle emissions and industrial sources in Edmonton, and industrial sources in the Fort Saskatchewan/Redwater/Lamont area.

This report provides the results of all five particulate matter and ozone assessments (spanning 2001 to 2007) as well as the overall, definitive actions levels that have been assigned to each region and each individual station based on the 2001 to 2007 time period.

TABLE OF CONTENTS

OVERVIEW i
TABLE OF CONTENTS iii
LIST OF FIGURES iv
LIST OF TABLES v
LIST OF ACRONYMS, ABBREVIATIONS AND SYMBOLS vi

1.0 BACKGROUND 1

2.0 ASSESSMENT PROCEDURE 3
2.1 Backing Out Natural, Background and Trans-boundary Influences 3
2.2 Notes on Data Handling 5
2.3 Assignment of Action Levels 5

3.0 ASSESSMENT RESULTS FROM 2001 TO 2007 7
3.1 Edmonton 9
3.2 Calgary (CRAZ airshed) & Red Deer (PAMZ airshed) 11
3.3 Fort Saskatchewan Area (FAP airshed) 13
3.4 West Central Alberta (WCAS airshed) 15
3.5 North Eastern Alberta (WBEA and LICA airsheds) 17
3.6 North Western Alberta (PASZA airshed) 19
3.7 Southern Alberta (Palliser airshed and Lethbridge) 21
3.8 Overall Observations for 2001-2007 22
3.9 Conditions Surrounding Episodes 23

4.0 FINAL ASSESSMENT RESULTS 27

APPENDIX 33

LIST OF FIGURES

Figure 1 Alberta's Particulate Matter and Ozone Management Framework. 2
Figure 2 PM and ozone episode analysis procedure for CWS and CASA action level determination. 3
Figure 3 Alberta Ambient Air Monitoring Stations. 9
Figure 4 $PM_{2.5}$ levels in Edmonton (2001-2007). 10
Figure 5 Ozone levels in Edmonton (2001-2007). 11
Figure 6 $PM_{2.5}$ levels in Calgary & PAMZ (2001-2007). 12
Figure 7 Ozone levels in Calgary & PAMZ (2001-2007). 13
Figure 8 $PM_{2.5}$ levels in the Fort Saskatchewan area (2001-2007). 14
Figure 9 Ozone levels in the Fort Saskatchewan area (2001-2007). 15
Figure 10 $PM_{2.5}$ levels in West Central Alberta (2001-2007). 16
Figure 11 Ozone levels in West Central Alberta (2001-2007). 17
Figure 12 $PM_{2.5}$ levels in North Eastern Alberta (2001-2007). 18
Figure 13 Ozone levels in North Eastern Alberta (2001-2007). 19
Figure 14 $PM_{2.5}$ levels in North Western Alberta (2001-2007). 20
Figure 15 Ozone levels in North Western Alberta (2001-2007). 20
Figure 16 $PM_{2.5}$ levels in Southern Alberta (2001-2007). 21
Figure 17 Ozone levels in Southern Alberta (2001-2007). 22
Figure 18 Final Assessment Results for $PM_{2.5}$ in Alberta over 2001-2007. 29
Figure 19 Final Assessment Results for Ozone in Alberta over 2001-2007. 30
Figure A1 Simplified procedure for evaluating exceedances of the $PM_{2.5}$ planning and surveillance triggers. 34
Figure A2 Simplified procedure for evaluating exceedances of the ozone planning trigger. 35
Figure A3 2001 – 2003 particulate matter and ozone assessment action levels. 36
Figure A4 2002 – 2004 particulate matter and ozone assessment action levels. 37
Figure A5 2003 – 2005 particulate matter and ozone assessment action levels. 38
Figure A6 2004 – 2006 particulate matter and ozone assessment action levels. 39
Figure A7 2004 – 2006 particulate matter and ozone assessment action levels. 40

LIST OF TABLES

Table 1 Typical Cause of PM and Ozone Episode by Season. 25
Table 2 Final $PM_{2.5}$ Action Levels by Area. 31
Table 3 Final Ozone Action Levels by Area. 31
Table A1 Annual and 3-year average $PM_{2.5}$ levels ($\mu g/m^3$) *before* backing out (2001-2007).. 41
Table A2 Annual and 3-year average $PM_{2.5}$ levels ($\mu g/m^3$) *after* backing out (2001-2007). ... 42
Table A3 Annual and 3-year average ozone levels (ppb) *before* backing out (2001-2007). 43
Table A4 Annual and 3-year average ozone levels (ppb) *after* backing out (2001-2007). 44

LIST OF ACRONYMS, ABBREVIATIONS AND SYMBOLS

ACAA	Alberta Capital Airshed Alliance
CASA	Clean Air Strategic Alliance
CCME	Canadian Council of Ministers of the Environment
CMA	Census Metropolitan Area
CO	Carbon Monoxide
CRAZ	Calgary Regional Airshed Zone
CWS	Canada-wide Standard(s)
FAP	Fort Air Partnership
GDAD	Guidance Document of Achievement Determination
LICA	Lakeland Industrial Community Association
NOx	Nitrogen Oxides
PAMZ	Parkland Air Management Zone
PAS	Palliser Airshed Society
PASZA	Peace Airshed Zone Association
PM	Particulate Matter
$PM_{2.5}$	Fine Particulate Matter (smaller than 2.5 microns)
O_3	Ozone
SO_2	Sulphur Dioxide
Temp	Temperature
WBEA	Wood Buffalo Environmental Association
WCAS	West Central Airshed Society
ppb	Parts per billion
$\mu g/m^3$	Micrograms per cubic meter

1.0 BACKGROUND

The Canadian Council of Ministers of the Environment (CCME) established Canada Wide Standards for $PM_{2.5}$ and ozone in June 2000. Achievement of the CWS are based on the following numerical values and calculation method:

$PM_{2.5}$ — *30 $\mu g/m^3$ (micrograms per cubic meter), averaged over 24 hours, by year 2010. Achievement to be based on the 98th percentile ambient measurement annually, averaged over three consecutive years.*

Ozone — *65 parts per billion (ppb), eight-hour averaging time, by 2010. Achievement to be based on the 4th highest measurement annually averaged over three consecutive years.*

The CWS are based on the concepts of continuous improvement, pollution prevention and keeping-clean-areas-clean. The CCME will produce comprehensive reports on the standards every five years, beginning in 2006 with a report on progress. The first comprehensive report on each jurisdiction's achievement of the CWS was released by the CCME in November 2006. This report is available from the CCME website (www.ccme.ca). Annual reports on achievement and maintenance of the standards will begin in 2011. Jurisdictional implementation plans produced by each province and territory outline more comprehensive actions to achieve the standards for particulate matter and ozone by the 2010 target date.

The CASA PM and Ozone Management Framework is Alberta's commitment to develop an implementation plan to achieve the standards. Three action triggers and four action levels were established under the Framework. These are described as follows (and shown in Figure 1):

- **Action Level:** *Mandatory Plan to Reduce Below CWS* – value above the CWS exceedance trigger of 30 $\mu g/m^3$ (micrograms per cubic meter) for $PM_{2.5}$ or 65 ppb (parts per billion) for ozone.
  Action: Alberta Environment will develop and implement a management plan containing measures to reduce ambient concentrations to below the numeric CWS within two years, working with stakeholders where possible.
- **Action Level:** *Management Plan* – value above the planning trigger of 20 $\mu g/m^3$ for $PM_{2.5}$ or 58 ppb for ozone, and below the CWS exceedance trigger.
  Action: A management plan will be developed and implemented by stakeholders with appropriate actions that consider factors such as: (1) trends in population growth and industrial activity, (2) trends in ambient air quality, and (3) ambient concentrations relative to the planning trigger. The goal of the management plan level is to prevent a future exceedance of the CWS and to maintain or improve air quality. Alberta Environment may impose a plan if stakeholders do not develop a plan within two years.

- **Action Level:** *Surveillance Actions* – value above surveillance trigger[1] of 15 $\mu g/m^3$ for $PM_{2.5}$, and below the planning trigger.
  Action: Alberta Environment, with support from the airshed zones, should take steps to ensure that sources of elevated concentrations are determined and that trends in ambient concentrations are monitored and analyzed.
- **Action Level:** *Baseline Monitoring and Data Gathering* – value below surveillance trigger of 15 $\mu g/m^3$ for $PM_{2.5}$.
  Action: Alberta Environment or airshed zones should conduct ongoing monitoring of ambient air quality. No additional data analysis is required.

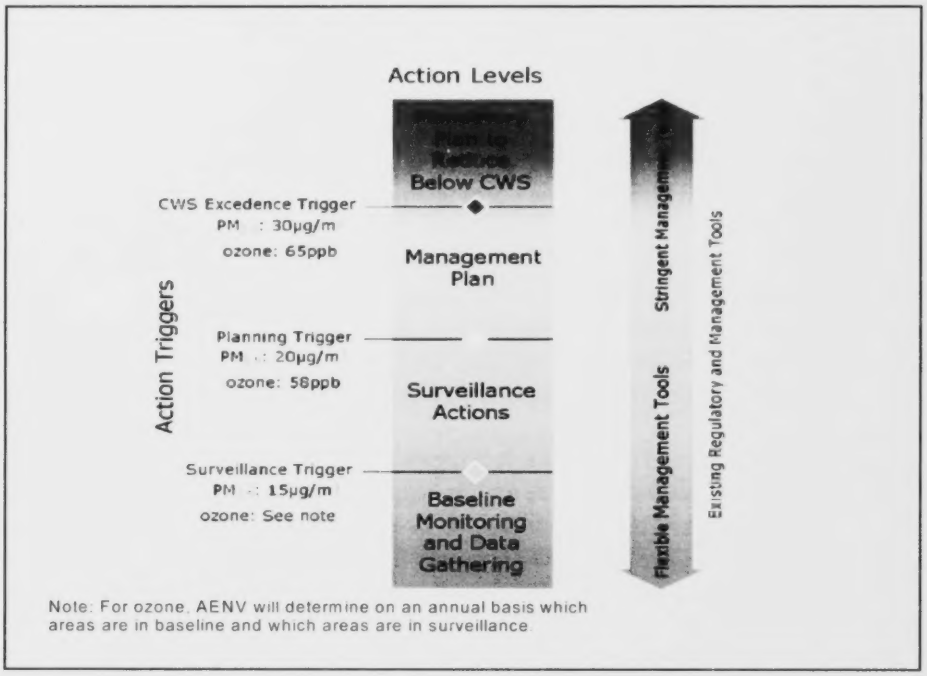


Figure 1 **Alberta's Particulate Matter and Ozone Management Framework.**
Extracted from CASA Particulate Matter and Ozone Management Framework (September 2003).

[1] Note that there is currently no surveillance trigger set for ozone. Alberta Environment will determine on an annual basis which areas are in baseline and which are in surveillance for ozone.

- **Action Level:** *Surveillance Actions* – value above surveillance trigger[1] of 15 $\mu g/m^3$ for $PM_{2.5}$, and below the planning trigger.
  Action: Alberta Environment, with support from the airshed zones, should take steps to ensure that sources of elevated concentrations are determined and that trends in ambient concentrations are monitored and analyzed.
- **Action Level:** *Baseline Monitoring and Data Gathering* – value below surveillance trigger of 15 $\mu g/m^3$ for $PM_{2.5}$.
  Action: Alberta Environment or airshed zones should conduct ongoing monitoring of ambient air quality. No additional data analysis is required.

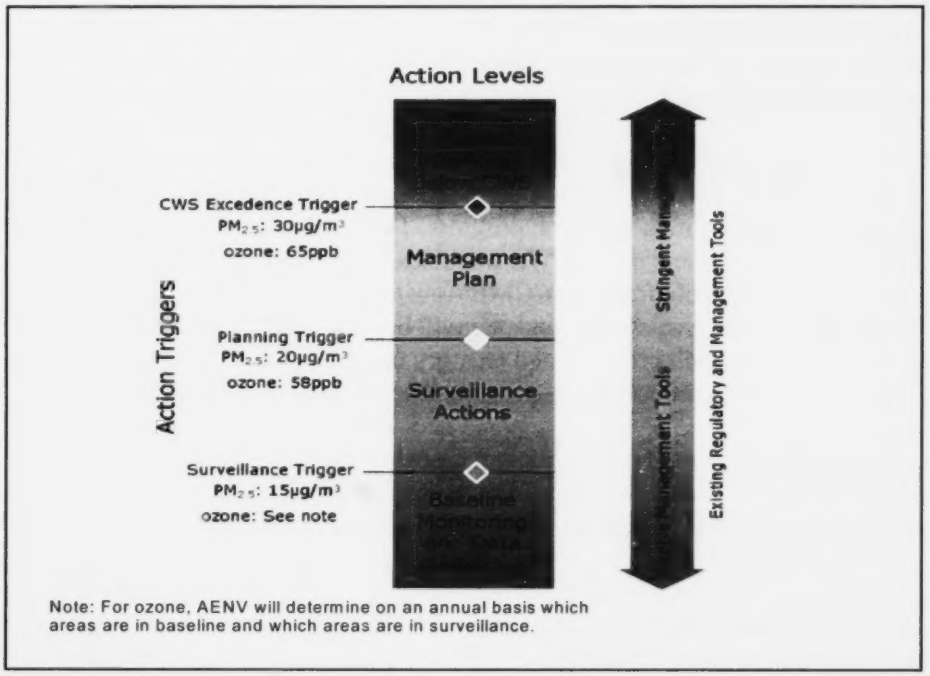


Figure 1 **Alberta's Particulate Matter and Ozone Management Framework.**
Extracted from CASA Particulate Matter and Ozone Management Framework (September 2003).

[1] Note that there is currently no surveillance trigger set for ozone. Alberta Environment will determine on an annual basis which areas are in baseline and which are in surveillance for ozone.

2.0 ASSESSMENT PROCEDURE

Each year, Alberta Environment analyzes the ambient $PM_{2.5}$ and ozone data collected from the provincial monitoring system and determines which areas fall into the action levels set out in the CASA Framework. This analysis is completed on a by-station basis and looks at the raw measured data and then determines whether the corresponding action triggers were exceeded as a result of emissions from anthropogenic sources within Alberta. The analysis is based on data contained in the CASA Data Warehouse (www.casadata.org). Individual $PM_{2.5}$ or ozone episodes that are primarily caused by natural events, high background or trans-boundary transport are removed from the calculation of the three-year metric using methodologies described in the national *Guidance Document of Achievement Determination* (GDAD) and the CASA Framework Guidance Document.

2.1 Backing Out Natural, Background and Trans-boundary Influences

Alberta Environment analyzes individual particulate matter and ozone episodes on an annual basis to determine the source or influence of each episode. If it can be demonstrated that an action trigger is exceeded as a result of natural, background or transboundary influences, those PM or ozone episodes are removed or "backed out" of the analysis and the level for that station is recalculated. The episode analysis procedure has two parts: (1) analysis of levels exceeding the CWS trigger and (2) analysis of levels exceeding the CASA action triggers (planning and surveillance triggers). The method described in the national *Guidance Document of Achievement Determination* (GDAD) document is followed for levels exceeding the CWS, while Alberta Environment has developed a Simplified Procedure for analyzing episodes that fall below the CWS trigger. The flow diagram below (Figure 2) illustrates this two-part analysis process.

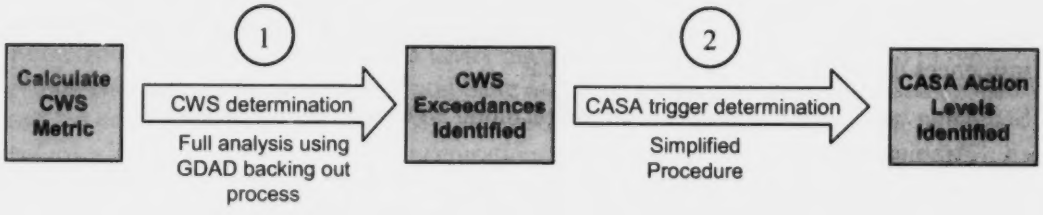


Figure 2 PM and ozone episode analysis procedure for CWS and CASA action level determination.

Part 1 of the episode analysis procedure includes the following steps for CWS determination:

a) Initial calculation of CWS value
b) Identify stations in exceedance
c) 'Demonstrating the Influence'
    - Identify episodes and gather background data

- Analyze the data
  - Time of year exceedance takes place
  - Spatial extent
  - Diurnal variation of ozone
  - Correlation with other contaminants
  - Meteorology (temperature, insolation, wind speed and direction)
  - Back trajectories
  - Forest fires
- Form a conclusion as to the cause of the episode

d) Decide whether or not the episode can be backed out

Part 2 of the analysis procedure was developed to simplify the process for CASA trigger exceedances and cut down on analysis time. The Simplified Procedure includes the following four mechanisms:

A. Organizing exceedances into episodes

Analyzing exceedances together as a unit when they occur over common time periods (consecutive days), in the same general area (airshed zone or adjacent airshed zones) and under the same atmospheric conditions and precursor levels.

B. Automation of the CWS calculation routines

Automatically calculate the CWS metrics (maximum daily eight-hour ozone concentration and 24-hour $PM_{2.5}$ concentration) by the CASA Data Warehouse so that annual ozone and PM values, along with subsequent three-year average values, can be computed quickly at the end of the year.

C. Real time episode analysis (for CWS trigger)

An Excel-based program has been set up to scan for exceedances of the CWS on a daily basis. In this way, CWS exceedances are identified and the source/influence determined in real time, when the ambient conditions are known and current. By using this simplified mechanism, all CWS exceedances will be analyzed and influences determined by the end of the year.

D. Screening criteria for exceedances of the planning and surveillance triggers

- Ambient Temperature/Time of Year
- Wind speed and direction
- Precursor Levels – minimum thresholds for ambient levels of oxides of nitrogen (NO_X), with carbon monoxide (CO) and sulphur dioxide (SO_2) used as indicators of man-made influence.

Figures A1 and A2 in the Appendix show the simplified procedure followed for analyzing particulate matter and ozone episodes below the CWS level. Note that the screening thresholds listed are used only as an initial guide to determine which episodes will undergo further assessment. They are based on previous PM and ozone research in Alberta and ambient monitoring data. These thresholds are not firm cut-offs. The conditions surrounding each episode are examined individually and episodes that do not meet the screening criteria thresholds may still be assessed further.

A detailed description of the episode analysis and simplified mechanisms procedure is given in the simplified mechanisms report (titled *Analyzing Exceedances of the Canada-Wide Standard for Particulate Matter and Ozone and the CASA Framework Triggers*). This report is available on Alberta Environment's website: http://environment.alberta.ca/1976.html.

2.2 Notes on Data Handling

$PM_{2.5}$ and ozone data are checked for data completeness on an annual basis, as outlined in the CWS GDAD process. The completeness criteria are different for $PM_{2.5}$ and ozone. $PM_{2.5}$ criteria requires at least 75% data completeness for each of the four quarters of the year. With ozone, a year's data is considered complete if data is available for 75% of the days in the 2nd and 3rd quarters of the year (when photochemical ozone production is prevalent). In the case of both $PM_{2.5}$ and ozone, at least two complete years must be available to calculate a three-year-average. Data not meeting the CWS calculation protocol for data availability are included in the analysis but flagged accordingly. This means that it is possible to exceed an action trigger at a station when the station does not have a complete annual data set. In this way, one year of incomplete data could skew a three year average for multiple assessments.

Rounding conventions are set out by the CWS GDAD process. As a result of these rounding conventions, it is possible for two stations to be assigned different action levels even though they appear to have the same numerical value. This is an effect of rounding the final three-year average to one decimal place for assigning action levels, while the comparison to the trigger level is done using two decimal places.

Monitoring stations have been added and removed over the course of the five assessments, and this is discussed in section 3.0 for each area of the province. In the case of ozone and the way that the CMA level is determined (the highest concentration is applied to the entire CMA), adding a new station within a CMA means that more data is contributed to the calculation of the CMA action level and there is greater potential for an increased ozone level for that CMA. In the case of $PM_{2.5}$, the addition of stations can either raise or lower the CMA level, since daily $PM_{2.5}$ concentrations are averaged across all stations to arrive at a CMA level.

2.3 Assignment of Action Levels

The purpose of the CASA Framework and assigning action levels to Alberta monitoring stations is to identify the PM and ozone levels which can be managed. The idea is to prevent levels from approaching or reaching the CWS by managing the sources/influences beforehand. Because episodes caused by natural, background or trans-boundary influences are backed out to give final action levels, these levels describe what can be managed by airshed zones and Alberta Environment and are not intended to represent the current air quality or the state of the environment. Information on current air quality and the state of the environment are available at Alberta Environment's web site

(http://environment.alberta.ca/933.html for current air quality and http://www3.gov.ab.ca/env/soe/index.html for the state of the environment).

Action levels are assigned to individual stations and to Census Metropolitan Areas (Calgary and Edmonton CMAs) based on the final assessment value (three-year average $PM_{2.5}$ or ozone value) after natural, background and transboundary influences have been backed out. Once a station or area have been assigned to an action level, they remain in that action level until the associated actions have been carried out (a Management Plan for example) and it can be demonstrated that levels have been reduced below the action trigger.

It is possible for an area to be assigned to the *Management Plan* action level one year, then fall below the planning trigger the next year. In this case, once an area triggers the *Management Plan* action level, a management plan must be developed, even if in subsequent years pollutant concentrations are below the *Management Plan* action level. The *CASA Particulate Matter and Ozone Implementation Project Team* agreed by consensus that the highest assigned action level will remain, emphasizing that an area cannot go from action to inaction after a trigger level has been exceeded. The CASA Particulate Matter and Ozone Framework, however, is flexible and states (in section 3.4.2.3) that a management plan may consider either more or less stringent action depending on the concentration trends and the magnitude above the trigger. If trends are downward, actions taken may not need to be extensive, whereas if there are upward trends, actions taken may be significant. Hence, labour intensive efforts may not be needed when an area bounces in and out of the *Management Plan* Action level.

3.0 ASSESSMENT RESULTS FROM 2001 TO 2007

Alberta Environment completed the first particulate matter and ozone assessment (based on data from 2001 to 2003) in 2006, and stakeholders were notified of the results in November of that year. Following the first assessment, the Edmonton CMA and Calgary CMA as well as stations in the West Central, Parkland and Fort Saskatchewan area airsheds were assigned to the *Management Plan* action level for ozone. Stakeholders in these areas were given two years to develop an air quality management plan with the goal of preventing future exceedances of the CWS trigger.

Following the notification, airsheds assigned to the *Management Plan* action level worked with Alberta Environment and other stakeholders on a variety of initiatives, including:

- collection and review of ambient and emission data,
- identification of the sources unique to each region,
- defining the current state of the air quality,
- exploring a wide variety of policy tools for air quality management,
- educating and informing the public, and
- engaging all stakeholders, including the public in workshops and town hall meetings

These initiatives ultimately brought the three groups, the Capital Airshed Partnership (consisting of the Alberta Capital Airshed Alliance, Fort Air Partnership and West Central Airshed Society), the Calgary Region Airshed Zone and the Parkland Airshed Management Zone, to the development of air quality management plans for their respective regions. The goal of the management plans is to ensure that ozone smog levels remain lower than CWS limits. The airsheds submitted their completed air management plans to AENV by December 31, 2008. Alberta Environment is now in the process of reviewing the three plans and the recommendations for action. The next steps will be acceptance of the plans and ultimately implementation.

Since the first assessment, particulate matter and ozone levels have generally declined, with some stations being assigned to less stringent actions levels in subsequent assessments. This is largely because the first assessment included years with hot summers and ideal conditions for ozone production (especially in 2002), as well as numerous forest fires (especially in 2003) contributing to $PM_{2.5}$ events. The years following had cooler summers, more precipitation and less forest fire influence, and subsequently particulate matter and ozone levels were lower. Conditions in 2006 and 2007, however, were once again hot and dry and resulted in more ozone episodes. This demonstrates how ozone and particulate matter levels in Alberta are largely driven by meteorology, including temperature, air circulation and in the case of PM, forest fires.

The following sections discuss changes in the particulate matter and ozone assessments over 2001 to 2007 on a by-region basis. The results discussed in this section are the final assessment action levels (after backing out natural, background and trans-boundary influences). The results of all four assessments (from 2001 – 2006) are given in the

Appendix (Figures A3 to A7 and Tables A1 to A4), including both pre-assessment action levels and action levels after backing out influences due to natural, background or trans-boundary influence. Data completeness on an annual basis is also provided in these tables. The air monitoring stations in the province have been organized into regions, for the purpose of this report, as follows (see Figure 3 for station locations):

- Edmonton: including the Edmonton Central, Edmonton East, Edmonton Northwest (up to 2005) and Edmonton South (starting 2005) stations (operated by Alberta Environment).
- Calgary and Red Deer Area: including the Calgary Central, Calgary East and Calgary Northwest stations (operated by Alberta Environment) and the Red Deer and Caroline stations in the Parkland Airshed Management Zone (PAMZ). Operation of the Calgary stations was taken over by the Calgary Regional Airshed Zone (CRAZ) in 2008.
- Fort Saskatchewan Area: including the Fort Saskatchewan, Lamont, Elk Island and Redwater stations in the Fort Air Partnership (FAP) airshed.
- West Central Alberta: including the Hightower Ridge, Violet Grove, Tomahawk, Carrot Creek, Steeper, Genesee, Powers, Breton, Drayton Valley and Edson stations in the West Central Airshed Society (WCAS).
- North Eastern Alberta: including the Fort McMurray-Athabasca Valley, Fort McMurray-Patricia McInnes, Fort Chipewyan, Fort McKay, Albian Mine Site, Millennium and Syncrude UE1 stations in the Wood Buffalo Environmental Association (WBEA) airshed, and the Cold Lake station in the Lakeland Industrial Community Association (LICA).
- North Western Alberta: including the Beaverlodge, Grande Prairie-Henry Pirker, Smokey Heights and Evergreen Park stations in the Peace Airshed Zone Association (PASZA).
- Southern Alberta: including the Lethbridge station (operated by Alberta Environment) and Medicine Hat-Crescent Heights station (operated by the Palliser Airshed Society, or PAS).

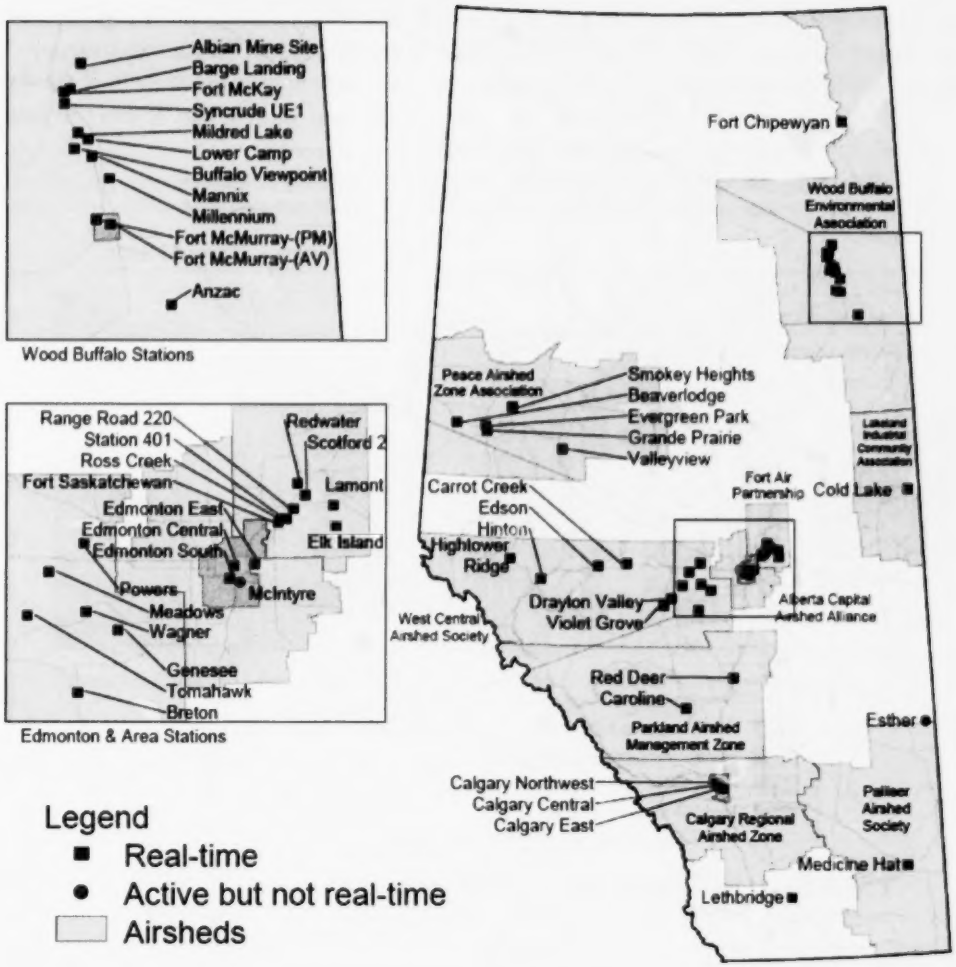


Figure 3 Alberta Ambient Air Monitoring Stations.

3.1 Edmonton

$PM_{2.5}$

Fine particulate matter levels in Edmonton have decreased over the 2001-2007 time period at all stations (Figure 4). The Edmonton Northwest station was assigned to the *Management Plan* action level in 2003, but fell below the planning trigger in the next three assessments. The Edmonton Northwest station was moved following 2005 because development in the area was moving too close to the site and the siting criteria was no longer met. The other Edmonton stations were assigned to either the *Surveillance* or *Baseline Monitoring* action levels over 2001-2007. Note that the Edmonton South station commenced monitoring near the end of 2005.

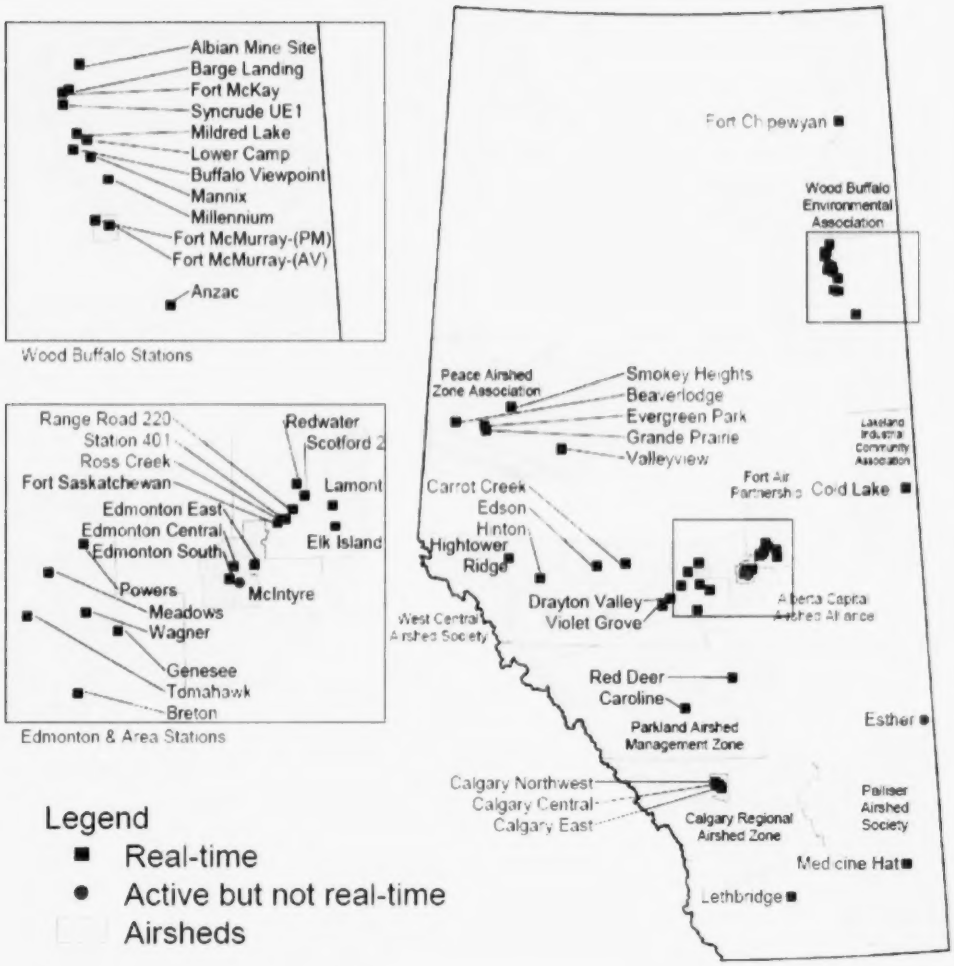


Figure 3 Alberta Ambient Air Monitoring Stations.

3.1 Edmonton

$PM_{2.5}$

Fine particulate matter levels in Edmonton have decreased over the 2001-2007 time period at all stations (Figure 4). The Edmonton Northwest station was assigned to the *Management Plan* action level in 2003, but fell below the planning trigger in the next three assessments. The Edmonton Northwest station was moved following 2005 because development in the area was moving too close to the site and the siting criteria was no longer met. The other Edmonton stations were assigned to either the *Surveillance* or *Baseline Monitoring* action levels over 2001-2007. Note that the Edmonton South station commenced monitoring near the end of 2005.

Particulate matter episodes in Edmonton are generally driven by forest fire smoke influence in the summer and originate from anthropogenic (vehicle and industrial emission) sources during stagnant wind conditions in the wintertime.

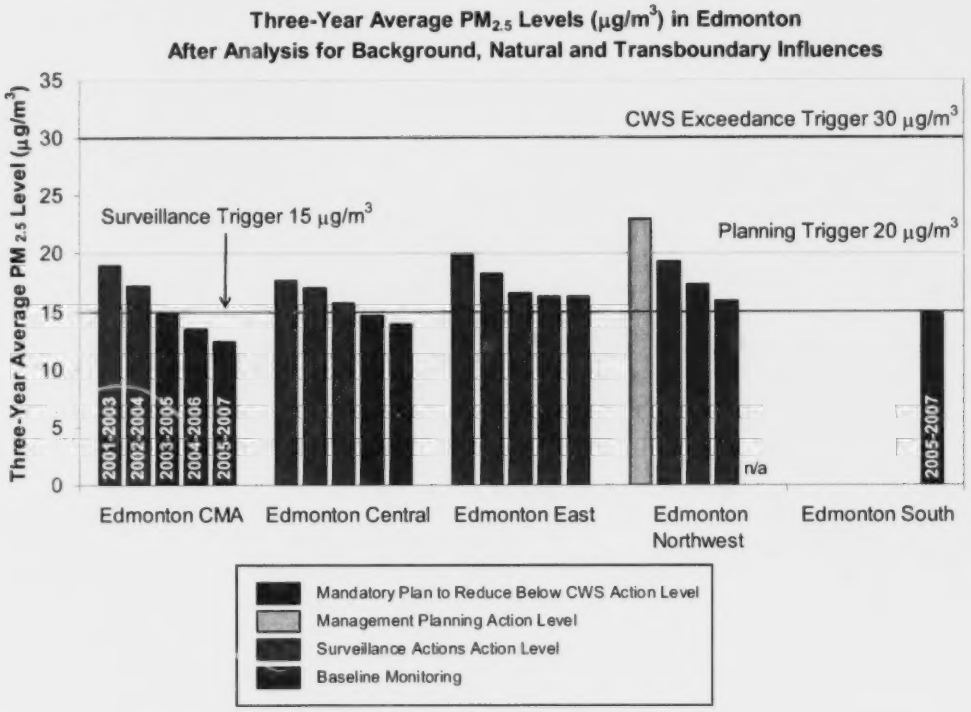


Figure 4 $PM_{2.5}$ levels in Edmonton (2001-2007).

Ozone

Ozone levels in Edmonton have decreased over 2001-2007 at all stations (Figure 5). The Edmonton East and Northwest stations were assigned to the *Management Plan* action level in 2003 and 2004, but fell below the planning trigger in 2005, 2006 and 2007. The Edmonton South station has been assigned to the *Management Plan* action level in the 2007 assessment. The Edmonton CMA was assigned to the *Management Plan* action level in all five assessments. Note that the Edmonton CMA includes the Edmonton stations as well as the Fort Saskatchewan, Tomahawk and Genesee stations. The *Management Plan* action level was triggered by Tomahawk in 2003 and 2004 and by Genesee in 2005, 2006 and 2007. The summer of 2002 was hot and resulted in several anthropogenic ozone events. Very high ozone levels at the Tomahawk station in 2002 brought the Edmonton CMA level right to the CWS exceedance trigger for the 2002-2004 assessment. The trigger however was not exceeded. The Edmonton Northwest station ceased operation at the end of 2005 and the Edmonton South station started monitoring in 2005.

Ozone episodes in Edmonton are generally of anthropogenic origin (vehicle and industrial emissions) during the summer months. Episodes typically occur on hot days when there is

little air circulation and ozone precursors are able to build up. Edmonton is influenced by background ozone as well, especially in the springtime. Ozone is transported from the west or down from aloft during large-scale disturbances (such as frontal activity). Ozone levels in the summer months can also be augmented by forest fire smoke.

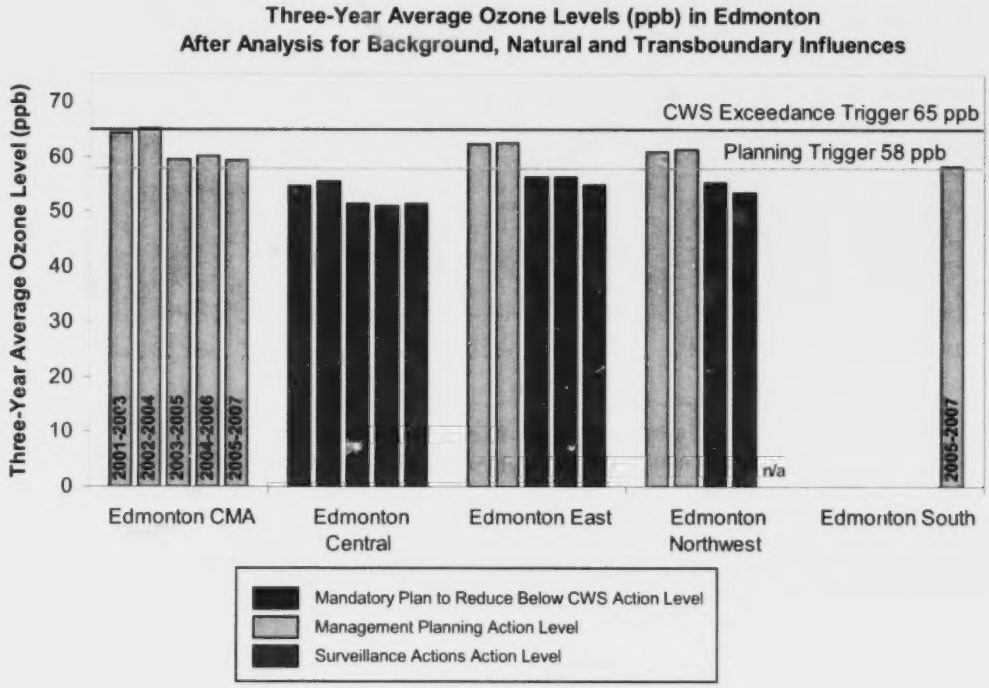


Figure 5 Ozone levels in Edmonton (2001-2007).

3.2 Calgary (CRAZ airshed) & Red Deer (PAMZ airshed)

$PM_{2.5}$

Fine particulate matter levels in Calgary have generally decreased over the 2001-2007 time period at all stations (Figure 6). Calgary Central and Calgary East have been assigned to the *Surveillance* action level, with the Calgary Central station falling below the *Surveillance* action after 2005. The Calgary East station has remained in the *Surveillance Actions* action level throughout 2003-2007. Calgary Northwest and Red Deer have remained below the *Surveillance Actions* action level for all of 2001-2007. The Calgary East and Northwest stations did not start monitoring for $PM_{2.5}$ until the end of 2002.

Particulate matter episodes in Calgary and Red Deer are mainly influenced by forest fire smoke in the summertime. Calgary is also influenced by anthropogenic sources (vehicle and industrial emissions) during stagnant wind conditions in the wintertime.

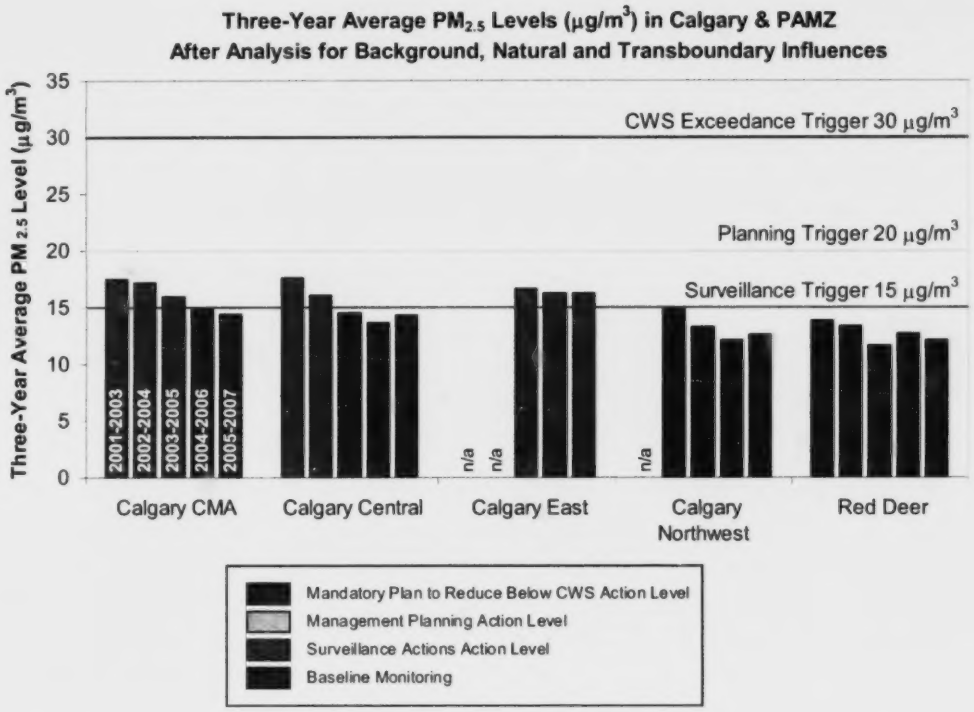


Figure 6 $PM_{2.5}$ levels in Calgary & PAMZ (2001-2007).

Ozone

Ozone levels in Calgary and the PAMZ airshed have generally decreased over the 2001-2007 time period (Figure 7). The Calgary CMA as well as the Calgary Northwest, Red Deer and Caroline stations were assigned to the *Management Plan* action level for 2003 and 2004, but fell below the planning trigger in the next three assessments. The Calgary Central and East stations have been assigned to the *Surveillance Actions* action level for all four assessments.

Ozone levels in Calgary are driven by a very different mechanism than ozone levels in Edmonton. Calgary (in particular the Northwest station) is influenced by anthropogenic sources (vehicle and industrial emissions) during hot summer days, as is the case in Edmonton, but Calgary does not see the springtime ozone episodes from background influence that Edmonton sees so prominently. Calgary ozone levels in the summer months can also be augmented by forest fire smoke.

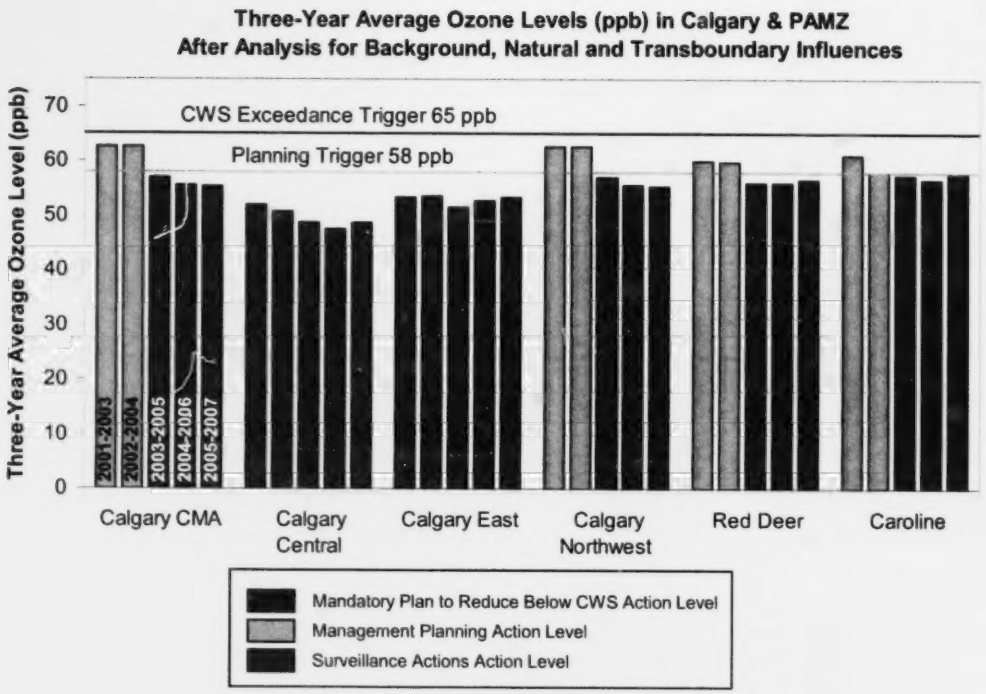


Figure 7 Ozone levels in Calgary & PAMZ (2001-2007).

3.3 Fort Saskatchewan Area (FAP airshed)

$PM_{2.5}$

Fine particulate levels have declined in the Fort Saskatchewan area since 2001 (Figure 8). Fort Saskatchewan exceeded the planning trigger for 2001-2003, however this assessment was based on incomplete data. The 2001 $PM_{2.5}$ value was only based on two months of data, but was included in the three-year average according to the CWS calculation procedure. The high $PM_{2.5}$ value for the two-month period in 2001 ended up skewing the three-year average and making it non-representative of the three-year period. Following the first assessment, Fort Saskatchewan was assigned to the *Surveillance* action level in 2004 and then the *Baseline Monitoring* action level in 2004, 2006 and 2007. Lamont has been assigned to the *Surveillance* action level for all available assessments, while Elk Island was in the *Surveillance* action level in 2004, but has since been in the *Baseline Monitoring* action level. Lamont and Elk Island did not begin monitoring for $PM_{2.5}$ until 2003. Redwater was assigned to the *Surveillance* action level for 2005-2007.

Particulate matter in the Fort Air Partnership airshed generally comes from anthropogenic sources (from nearby industrial activity) in the wintertime and forest fire smoke in the summertime. Lamont is heavily influenced by upwind Fort Saskatchewan and other adjacent industrial activity. Elk Island is influenced by upwind industrial sources in the wintertime, but the monitor picks up local particulate matter sources in the summer – mainly camp fire from the nearby campsite and staff residences.

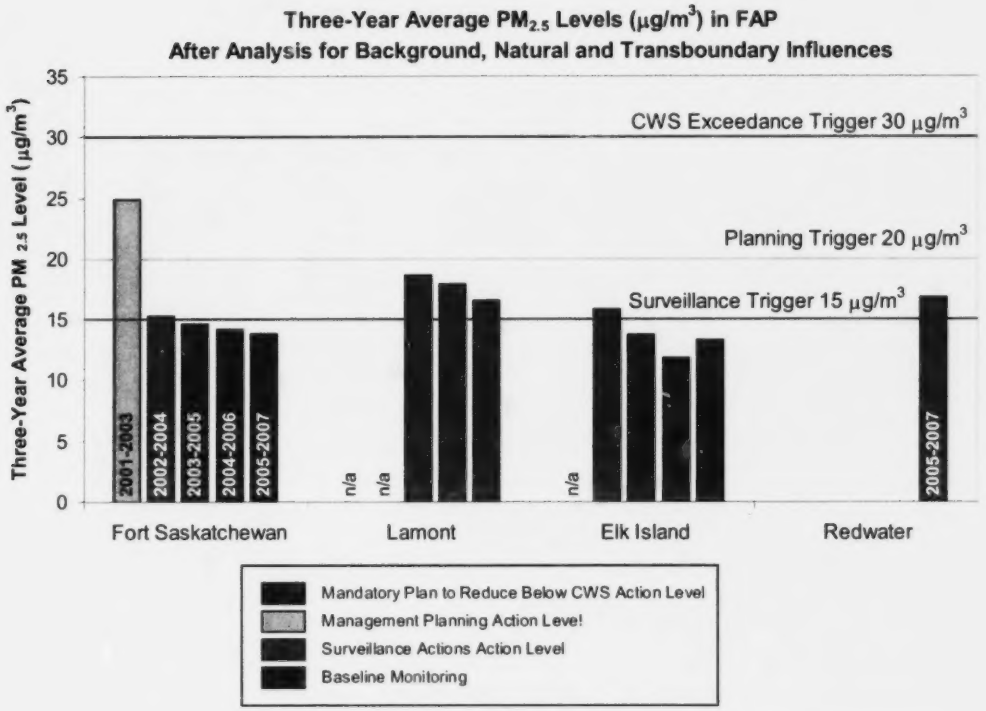


Figure 8 $PM_{2.5}$ levels in the Fort Saskatchewan area (2001-2007).

Ozone

Ozone levels at the Fort Saskatchewan station have decreased over the 2001-2006 time period (Figure 9), however levels at Lamont and Elk Island have remained fairly consistent. Fort Saskatchewan was assigned to the *Management Plan* action level for the 2003 and 2004 assessments, due to a hot summer and several anthropogenic episodes in 2002. However, ozone levels in Fort Saskatchewan fell into the *Surveillance Actions* action level for 2005, 2006 and 2007. Lamont and Elk Island have remained in the *Surveillance Actions* action level for all five assessments, but ozone levels at these stations are approaching the planning trigger. Lamont and Elk Island did not begin monitoring for ozone until 2003.

Sources of ozone in the Fort Air Partnership airshed include background influence in the spring months (March – May), and anthropogenic influence (from nearby industry and/or upwind Edmonton) during the summertime. These stations can also be influenced by forest fire events in the summer. As with $PM_{2.5}$, Elk Island and Lamont are heavily influenced by upwind Fort Saskatchewan and Edmonton, as well as other adjacent industrial activity.

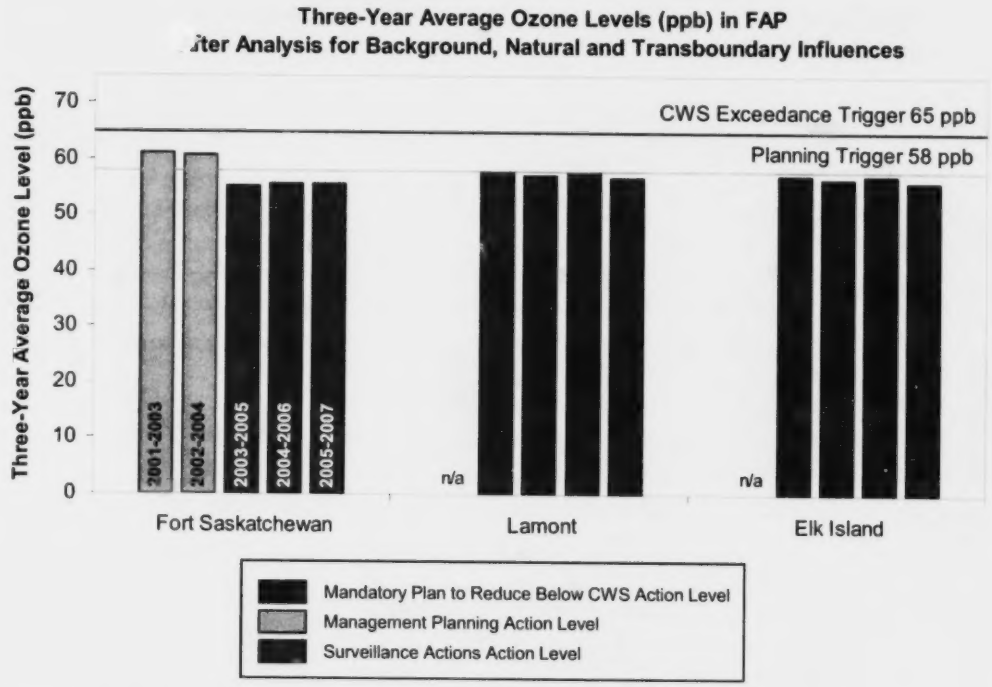


Figure 9 Ozone levels in the Fort Saskatchewan area (2001-2007).

3.4 West Central Alberta (WCAS airshed)

$PM_{2.5}$

Fine particulate levels in the West Central airshed have remained below the surveillance trigger in all five assessments (Figure 10), except for the Drayton Valley station. Drayton valley was assigned to the *Surveillance Actions* action level for 2005-2007, while all other stations in the area remained in the *Baseline Actions* action level since 2001. $PM_{2.5}$ levels at the Tomahawk station have declined over 2001-2007. The West Central airshed has had many station changes over the 2001-2007 time period. Hightower Ridge ceased monitoring in 2004, but monitoring started up again at the end of 2007. The Genesee, Powers and Edson stations began monitoring $PM_{2.5}$ in mid to late 2004, while the Drayton Valley station began monitoring in 2005.

The main source of $PM_{2.5}$ in the West Central airshed is forest fire in the summer months, with some anthropogenic episodes during periods of stagnant wind in the wintertime. Particulate matter and precursors for these episodes comes from nearby power plants and other industrial activity in the area.

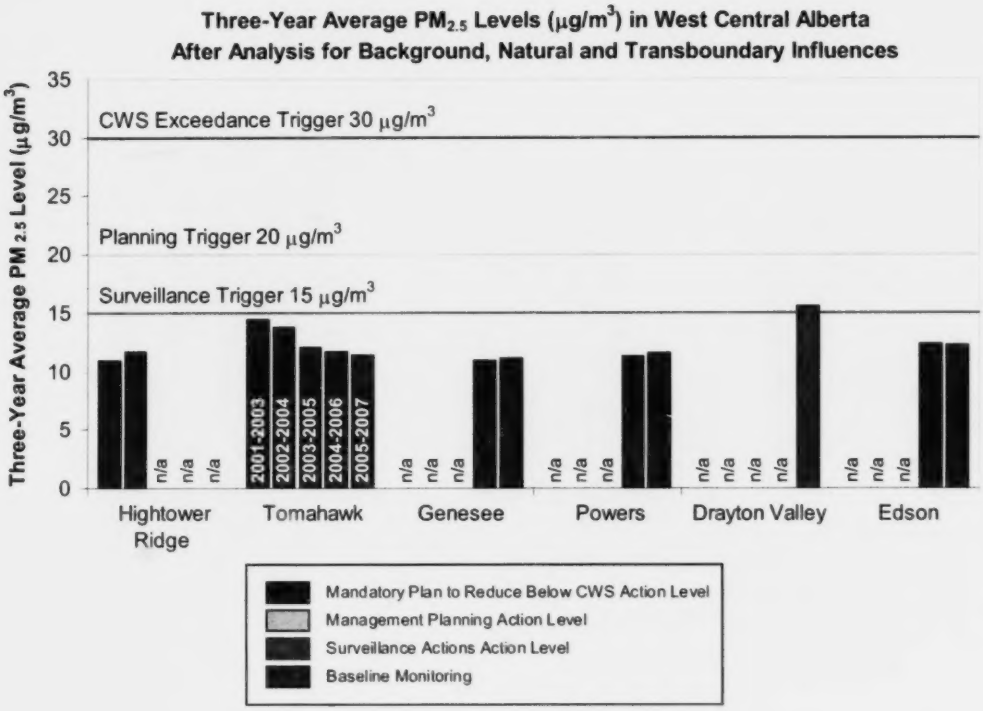


Figure 10 $PM_{2.5}$ levels in West Central Alberta (2001-2007).

Ozone

Ozone levels in West Central Alberta have remained fairly consistent from 2001 to 2007, but have declined at the Tomahawk station (Figure 11). Violet Grove, Tomahawk and Carrot Creek were all assigned to the *Management Plan* action level for the 2001-2003 and 2002-2004 assessments. This was mainly a result of a hot summer and very high ozone levels in 2002, which were attributed to anthropogenic influence both in WCAS and Edmonton. In recent assessments, Violet Grove has dropped to just below planning trigger to the *Surveillance Actions* action level. Tomahawk dropped below the planning trigger in 2005, raised back into the *Management Plan* action level in 2006, and then dropped back down into the *Surveillance Actions* action level in the most recent 2007 assessment. Carrot Creek was assigned to the *Management Plan* action level for the first four assessments, remaining at a consistent ozone level just below the magnitude of the planning trigger. In the 2007 assessment, Carrot Creek fell below the planning trigger and was assigned to the *Surveillance Actions* action level. The Genesee station has been assigned to the *Management Plan* action level in all three available assessments (2005, 2006 and 2007) and has remained at a consistent level, just above the planning trigger. Ozone levels at the Genesee station have been the highest in the province for the last two assessments. Because Genesee falls within the Edmonton CMA, the high annual ozone levels at this station have kept Edmonton CMA in the *Management Plan* action level. The Breton station was assigned to the *Surveillance Actions* action level for 2005-2007. Note that the Steeper station ceased monitoring in 2003 and the Hightower station ceased monitoring at the end of

2004. Genesee began monitoring for ozone at the beginning of 2004 and Breton began monitoring in 2006.

Ozone episodes at WCAS stations are generally influenced by background ozone in the springtime and forest fire or occasional influence from upwind (Edmonton) anthropogenic sources in the summertime, during periods of hot weather. The Genesee station has more anthropogenic-based episodes in the summer than the other stations. This is likely due to its proximity to industrial sources and to Edmonton. The Carrot Creek and Tomahawk stations can also receive precursors from upwind Edmonton during the right conditions. Although some stations have fallen below the planning trigger for ozone, all stations in the West Central area have remained very close to the planning trigger level.

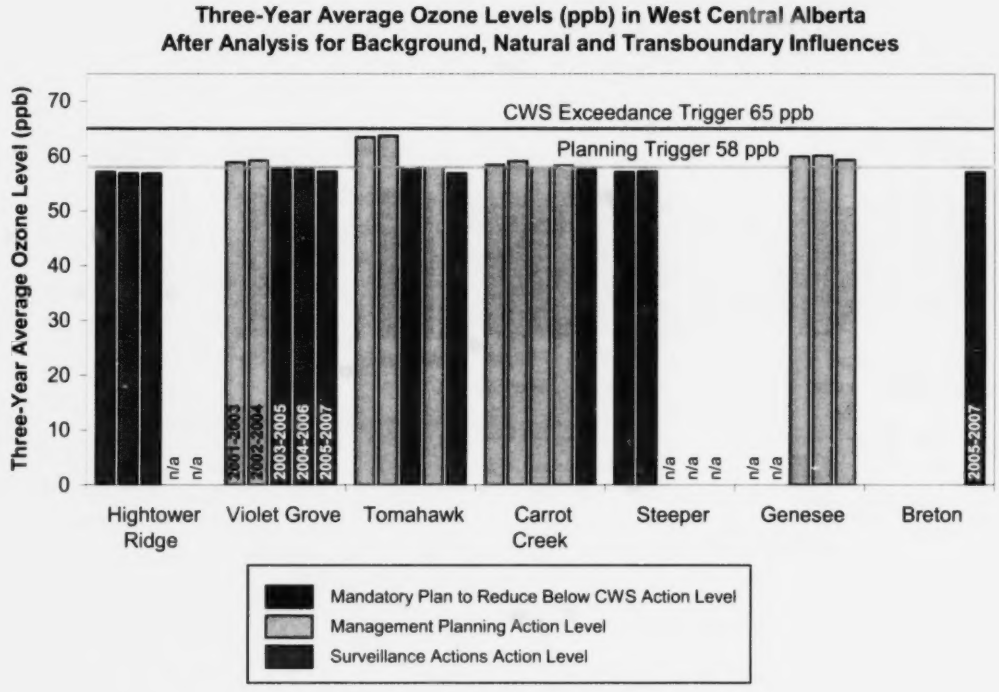


Figure 11 Ozone levels in West Central Alberta (2001-2007).

3.5 North Eastern Alberta (WBEA and LICA airsheds)

$PM_{2.5}$

Fine particulate matter levels in north eastern Alberta have remained below the surveillance trigger over 2001-2007, with all stations in the WBEA and LICA airsheds being assigned to the *Baseline Monitoring* action level (Figure 12). The Albian Mine and Millennium sites began monitoring in 2001 therefore the first assessment is based on an incomplete data set. Millennium is also missing a large portion of $PM_{2.5}$ data in 2003 as well as a portion

spanning the winter between 2006 and 2007. The Syncrude UE1 station began monitoring for $PM_{2.5}$ in mid-2002 and the Cold Lake station began monitoring in 2006.

Fine particulate matter levels in northern Alberta are largely driven by forest fire smoke influence, with many episodes being backed out of the analysis for this reason. Anthropogenic sources (industrial activity in the area) influence $PM_{2.5}$ levels in the wintertime during periods of stagnant winds.

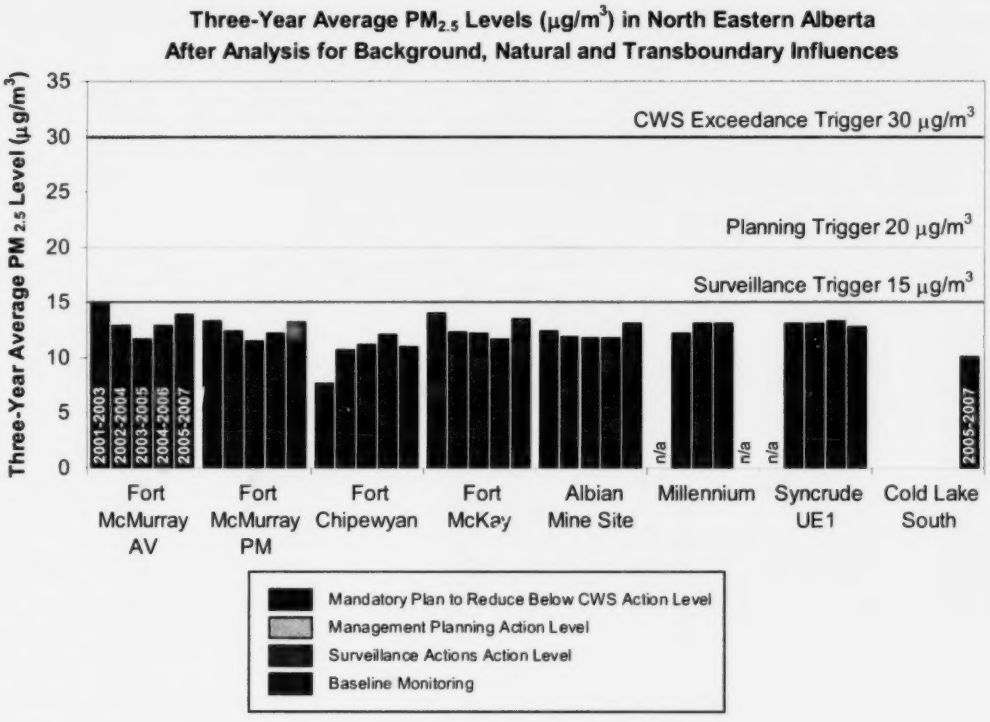


Figure 12 $PM_{2.5}$ levels in North Eastern Alberta (2001-2007).

Ozone

Ozone levels in north eastern Alberta have remained below the planning trigger over the 2001-2007 time period, with only slight variations in magnitude from year to year (Figure 13). All stations in the WBEA and LICA airsheds have been assigned to the *Surveillance Actions* action level for ozone in all five assessments. The Syncrude UE1 station began monitoring for ozone in late 2002 and the Cold Lake station began monitoring in 2006. The ozone level at the Cold Lake station was just below the planning trigger for 2005-2007.

Ozone levels in north eastern Alberta are most influenced by background ozone in the springtime (March-May). Anthropogenic episodes do occur occasionally in the Fort McMurray region in the summertime, during periods of hot weather. The stations in the WBEA and LICA airsheds can also be influenced by forest fire events in the summertime.

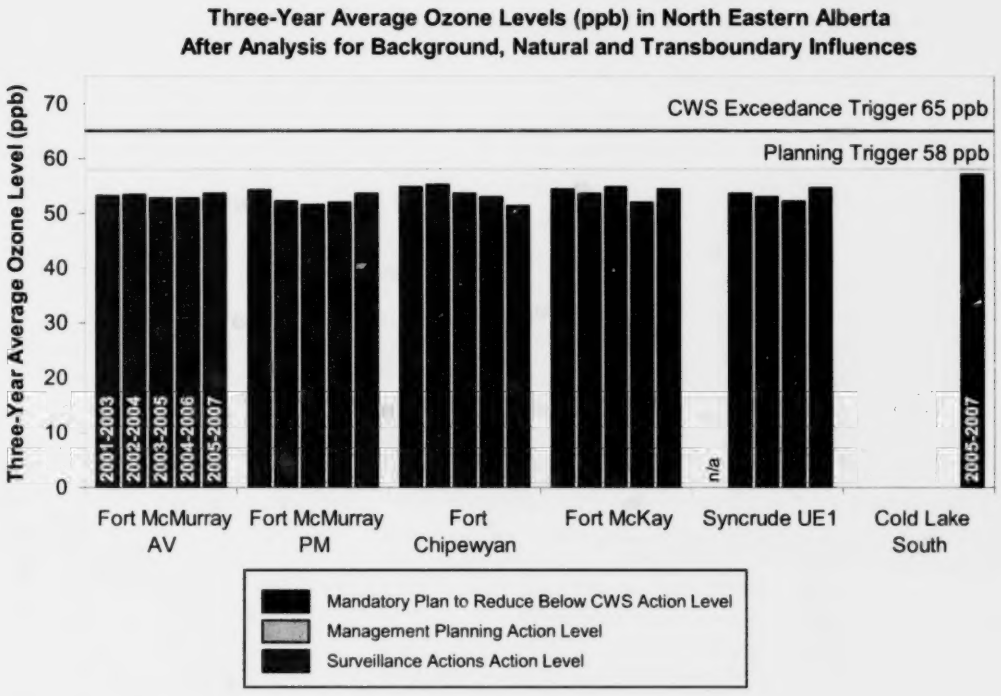


Figure 13 Ozone levels in North Eastern Alberta (2001-2007).

3.6 North Western Alberta (PASZA airshed)

$PM_{2.5}$

Fine particulate levels in north western Alberta have remained in the *Baseline Monitoring* action level since monitoring started (Figure 14). The Grande Prairie station began monitoring for $PM_{2.5}$ in 2004, while Beaverlodge, Evergreen Park and Smokey Heights began monitoring in 2005.

Ozone

Ozone levels in north western Alberta have remained below the planning trigger since the first assessment (Figure 15). Both Beaverlodge and Grande Prairie have been assigned *Surveillance Actions* action level for all assessments from 2001 to 2007. Grande Prairie began monitoring in 2004 therefore the 2003-2005 assessment is based on an incomplete data set for this station.

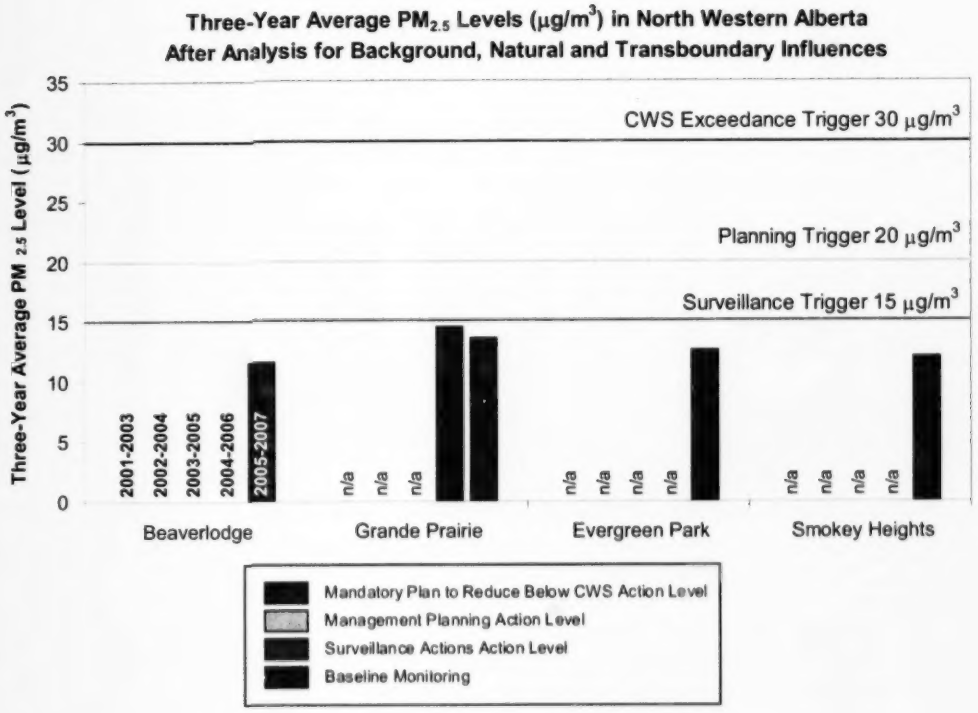


Figure 14 **$PM_{2.5}$ levels in North Western Alberta (2001-2007).**

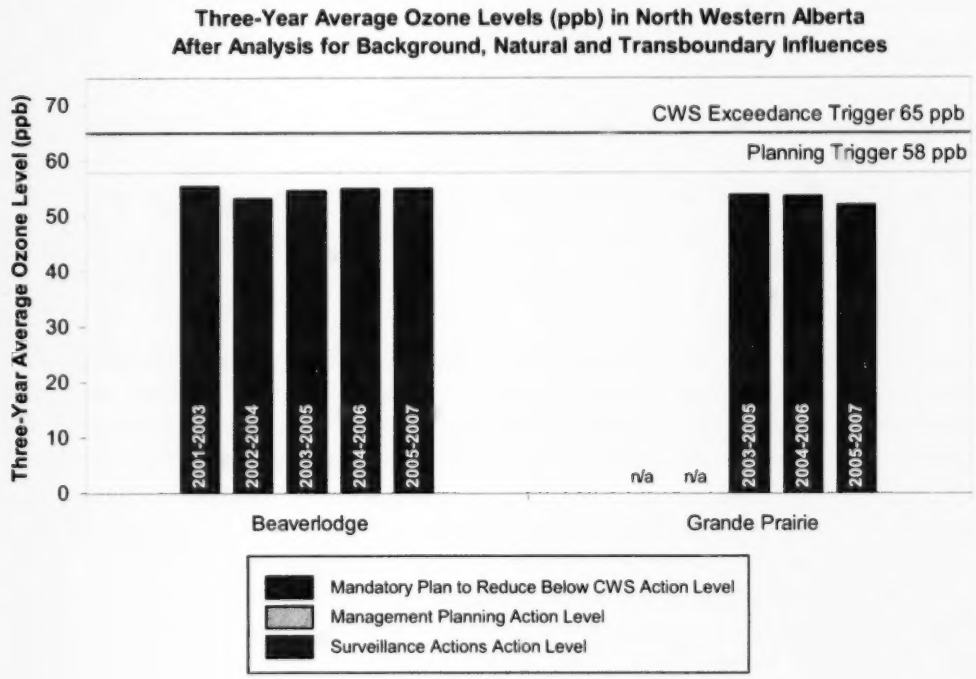


Figure 15 **Ozone levels in North Western Alberta (2001-2007).**

3.7 Southern Alberta (Palliser airshed and Lethbridge)

$PM_{2.5}$

Fine particulate levels in southern Alberta are low in comparison to the rest of the province. In the last three assessments, Lethbridge has been assigned to the *Baseline Monitoring* action level for $PM_{2.5}$ and Medicine Hat has been assigned to the *Baseline Monitoring* action level in 2006 and 2007 (Figure 16). Lethbridge began monitoring for $PM_{2.5}$ in late 2003 therefore the 2003-2005 assessment is based on an incomplete data set. Medicine Hat began monitoring in the beginning of 2004.

Particulate matter levels in this region have been mainly influenced by forest fire events in the summertime.

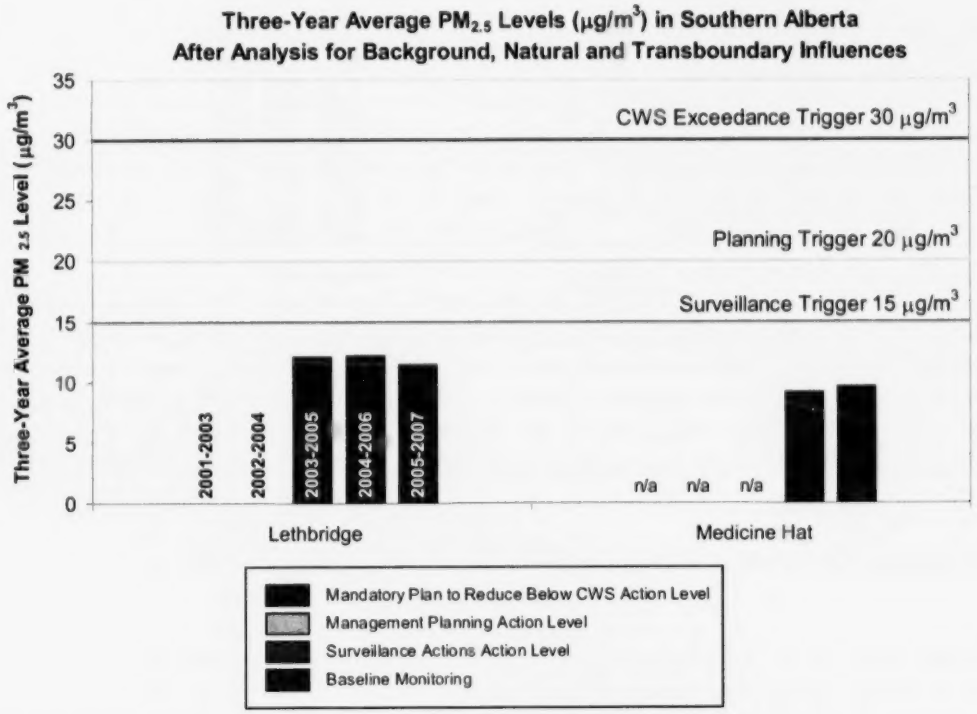


Figure 16 $PM_{2.5}$ levels in Southern Alberta (2001-2007).

Ozone

Ozone levels in southern Alberta have remained *Surveillance Actions* action level for the last three assessments, however the level is bordering just below the planning trigger value (Figure 17). Both Lethbridge and Medicine Hat began monitoring in 2004, therefore the 2003-2005 assessment is based on an incomplete data.

Ozone episodes in southern Alberta are mostly influenced by background ozone in the springtime (March-May). Lethbridge also had ozone episodes that were attributed to

background influence in the summertime in 2006. In Medicine Hat, however, ozone episodes are attributed to anthropogenic influence (likely from vehicle emissions) during hot summer days. These stations are also influenced by forest fire events during the summer months.

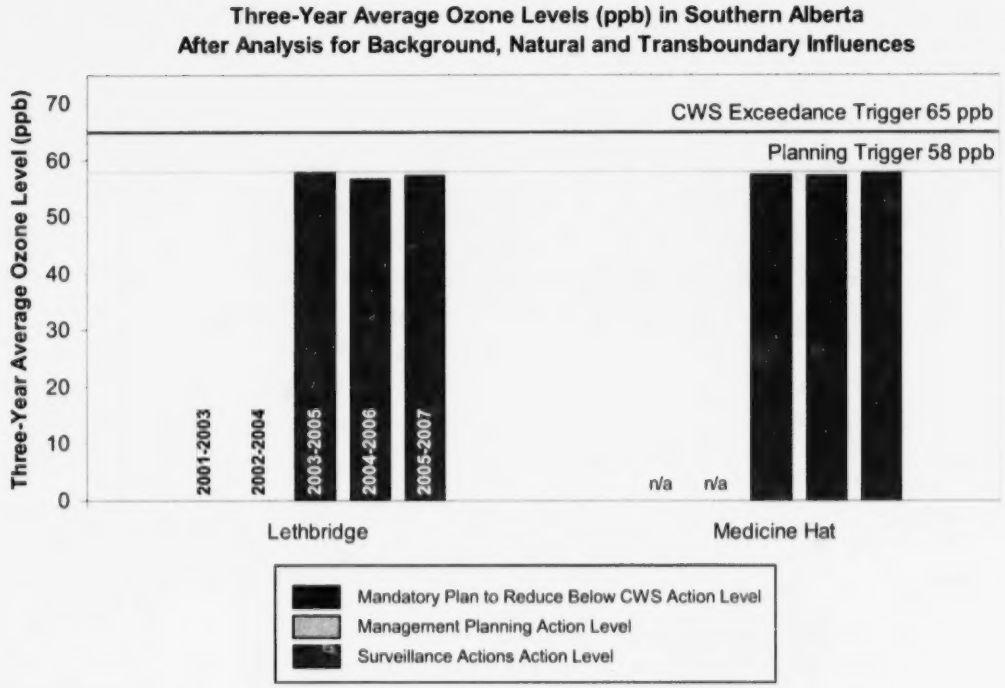


Figure 17 Ozone levels in Southern Alberta (2001-2007).

3.8 Overall Observations for 2001-2007

$PM_{2.5}$

Particulate matter is not as much of an issue as ozone is in Alberta based on assessing ambient data against Canada-wide Standard limits. Fine particulate matte concentrations have decreased since assessments began in 2001; most markedly in Edmonton, Calgary and West Central. The highest $PM_{2.5}$ levels are found at the Edmonton East, Calgary East, Redwater and Lamont stations, however these levels are still in the *Surveillance Actions* action level. $PM_{2.5}$ levels in the northeast, northwest and southern Alberta have remained below the surveillance trigger throughout 2001-2007 and are assigned to the *Baseline Monitoring* action level. In 2007, there were more particulate matter episodes than ozone episodes, which is contrary to previous years. Although there were more episodes, the $PM_{2.5}$ episodes were not of high magnitude. This directly relates to the structure of the CASA PM and Ozone Framework, which has a surveillance trigger for $PM_{2.5}$, but no surveillance trigger for ozone (see Figure 1).

Ozone

Ozone has generally decreased over 2001-2007, however the level is just below or at the planning trigger in the following areas: Edmonton, Calgary, PAMZ, FAP, WCAS and southern Alberta (Lethbridge and Medicine Hat). Ozone levels in the northeast and northwest have remained below the planning trigger and have been assigned to the *Surveillance Actions* action level for all assessments. The following are stations to watch for:

- Tomahawk – has approached the ozone CWS trigger in the past (2003 and 2004 assessments)
- Cold Lake South, Lethbridge and Medicine Hat – levels are just below the planning trigger for ozone
- Genesee – currently dictates the Edmonton CMA level for ozone (around 60 ppb in the last three assessments)

Ozone concentrations in Edmonton are lower than downwind in Fort Saskatchewan and Lamont. There are several sources of ozone precursors, including the power plants in the west, vehicle emissions and industrial emissions in Edmonton and the industrial activity in the Fort Saskatchewan/Redwater/Lamont area. It is possible that ozone produced within or transported into Edmonton is consumed by oxides of nitrogen (from vehicle exhaust), but precursors from the eastern Edmonton industrial area are transported downwind, producing ozone in FAP by secondary or tertiary reactions.

The Edmonton South station began monitoring in 2005. This station has adequate data for only one assessment (2005-2007), however it reports higher concentrations than the other Edmonton stations (Central and East). The lowest ozone concentrations are recorded at the Central station (likely because the high traffic volume in the downtown core causes ozone destruction by oxides of nitrogen). Ozone levels at Edmonton South may be higher due to ozone transport into the city from natural or background sources. However, this cannot be definitively determined based on the three years of data collected at this station.

Other areas of interest for ozone are Caroline (southwest of Red Deer) and Lamont (northeast of Fort Saskatchewan). Lamont is likely influenced by upwind Fort Saskatchewan, however concentrations in Lamont are always greater than concentrations in Fort Saskatchewan and Edmonton. Caroline is influenced by background ozone, but it is unclear whether or to what extent this station is influenced by Red Deer and west-central Alberta.

3.9 Conditions Surrounding Episodes

In Alberta, meteorology appears to be a major driver in particulate matter and ozone episodes. In the summer, hot days with little wind flow promotes ozone production and buildup of smog. Similarly, stagnant conditions in the wintertime, along with the presence of precursors, promotes build up of particulate matter and ozone. In the springtime, background influenced ozone episodes are common, as a westerly flow over the Rocky Mountains brings ozone down from aloft, or large scale frontal activity brings ozone-rich air down to the surface. Synoptic-scale airflow, air pressure and frontal activity generate one to

two province-wide ozone episodes per year. These normally occur in the springtime and can last three to five days. A common pattern during such episodes is a high pressure system above the province, with low pressure systems on either side (i.e., to the east and west). Evidence of trajectories descending and bringing air down toward the surface is also observed during these provincial-scale events. Table 1 below summarizes the common source and cause of ozone and $PM_{2.5}$ episodes in Alberta, by season. Ozone is more of an issue in Edmonton, while $PM_{2.5}$ is more of an issue in Calgary (related to forest fire influence).

Table 1 Typical Cause of PM and Ozone Episode by Season.

Season	Common $PM_{2.5}$ & Ozone Episode Conclusions
Spring	Background ozone (often province-wide episodes)
Summer	Anthropogenic/photochemical ozone; occasional background episodes Forest-fire related $PM_{2.5}$ (and sometimes ozone) Anthropogenic $PM_{2.5}$ production
Winter	Anthropogenic $PM_{2.5}$

After analyzing six years of $PM_{2.5}$ and ozone episodes, some patterns have become apparent. High-level ozone episodes (1-hour concentrations greater than the CWS magnitude) are generally background influenced (with possibly an anthropogenic component as well) and occur in the West Central area (e.g. Tomahawk). Ozone episodes that fall within the *Management Plan* action level (approximately 59-62 ppb) seem to be more anthropogenic in their cause and occur in Edmonton and the Fort Saskatchewan area. The difficult part of ozone episode analysis comes in when there is obvious contribution from both background and anthropogenic sources. In the current assessment process, AENV is not is not able to remove the background contribution to a single episode in order to determine solely the anthropogenic portion, which is manageable. Perhaps in the future, with developments in ozone modeling, the relative contributions of background and photochemically produced ozone will be understood for Alberta.

In the case of fine particulate matter episodes, there are three main circumstances – (i) wintertime episodes that occur during stagnant wind conditions, (ii) forest fire smoke influenced episodes in the summer, and (iii) anthropogenic episodes occurring in the summer due to influence from industry (oilsands area, Calgary, Redwater, Lamont and Drayton Valley).

4.0 FINAL ASSESSMENT RESULTS

Alberta Environment has completed five assessments of ambient levels of fine particulate matter and ozone in the province, in relation to the Canada-wide Standards, spanning 2001 to 2007. Following the first assessment (2001-2003), three areas of the province were assigned to the *Management Plan* action level for ozone: the Edmonton region (including the areas around Fort Saskatchewan and west-central Alberta), the Calgary region and the Red Deer region. Since the first assessment results were communicated, ozone levels have decreased at some stations and increased at others, however no new areas have been assigned to the *Management Plan* action level for ozone or for $PM_{2.5}$. Even though some stations have fallen below the planning trigger for ozone after 2003, the *CASA Particulate Matter and Ozone Implementation Project Team* agreed by consensus that the highest assigned action level will remain and that an area cannot go from action to inaction after a trigger level has been exceeded. Therefore, once an area triggers the *Management Plan* action level, a management plan must be developed. Such a plan would be developed as a living document so that if ozone or particulate matter levels decrease in an area (or increase), the plan's actions would be adjusted to account for this.

This section presents the final assessment results for the entire 2001 to 2007 period (Figures 18 and 19). That is, the highest action levels triggered by each individual station, after natural, background and transboundary influences have been backed-out.

For $PM_{2.5}$, two stations exceeded the planning trigger: Edmonton Northwest (in 2001-2003) and Fort Saskatchewan (also in 2001-2003). However, Alberta Environment decided not to assign these stations to the *Management Plan* action level for $PM_{2.5}$. In the case of Edmonton Northwest, development in the area was moving too close to the site and the siting criteria was no longer being met. The station was not capturing general air quality for the "residential"-zoned station, therefore the station was moved following 2005. The $PM_{2.5}$ level for Fort Saskatchewan was based on incomplete data, which was included in the three-year average according to the CWS calculation procedure. The two months of data available for 2001 included some $PM_{2.5}$ episodes which ended up skewing the three-year average and making it non-representative of the three-year period. All other stations in Alberta are below the planning trigger for $PM_{2.5}$, with only the Edmonton East (Edmonton CMA) and Lamont station coming within reach of the planning trigger over 2001-2007. Table 2 categorizes the station by overall $PM_{2.5}$ action level for the 2001-2007 period.

Five airsheds (and 14 stations) have been assigned to the *Management Plan* action level for ozone (Table 3). These comprise the Edmonton/Capital region (including the Fort Saskatchewan and west central areas), the Calgary census metropolitan area and the Red Deer/Parkland area. Alberta Environment notified the affected areas in November 2006 and work on the ozone management plans began in 2007 with various stakeholder engagement initiatives. Three ozone management plans were submitted to Alberta Environment in December of 2008. Upon review by Alberta Environment, the plans will be accepted and implementation procedures will begin. The management plans all include provisions for routine review and updating to keep the plan current and respond to changing PM and

ozone levels, economics, government initiatives and purveyance of additional information (for example modeling or emissions inventory results).

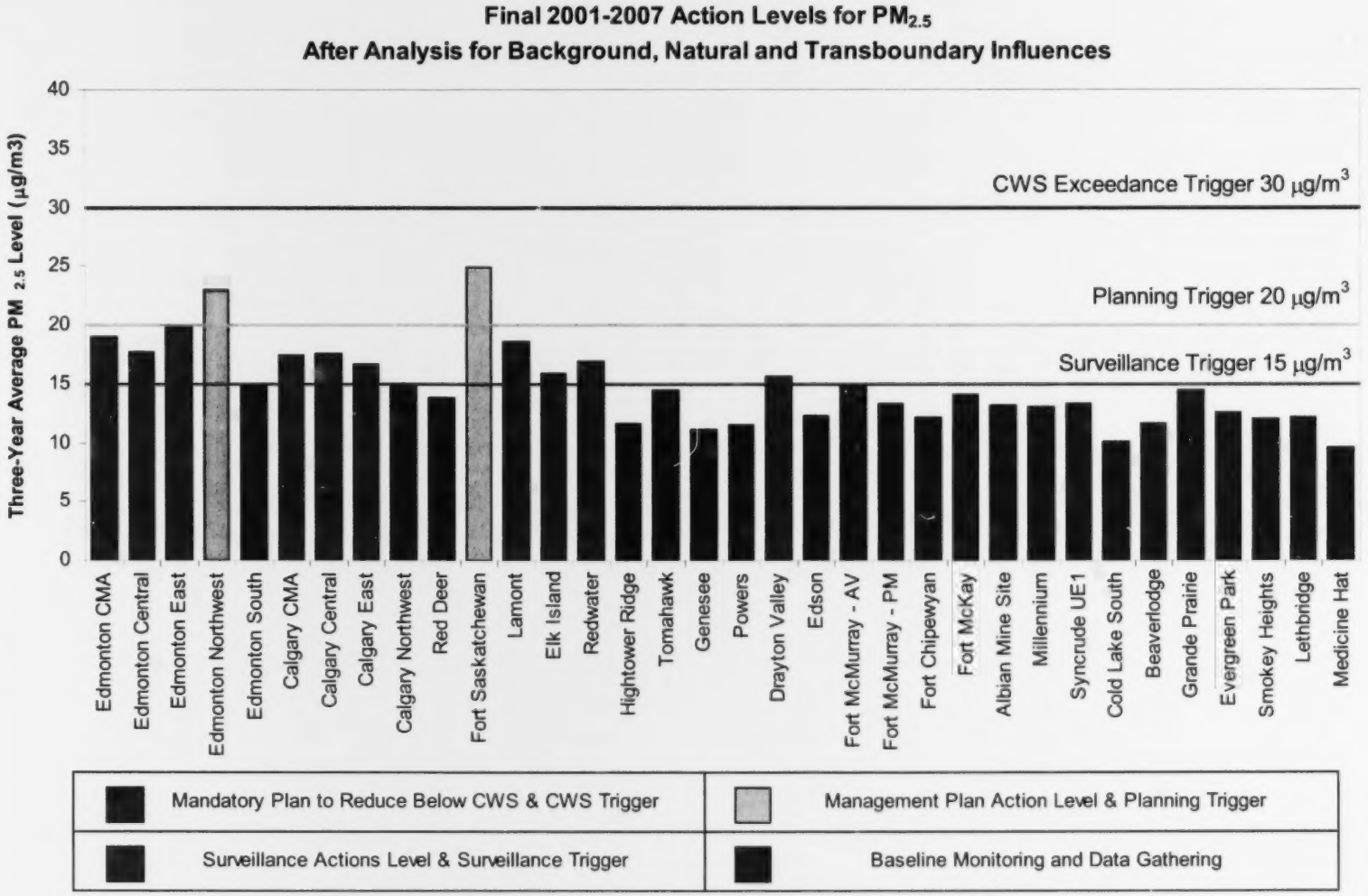


Figure 18 Final Assessment Results for $PM_{2.5}$ in Alberta over 2001-2007.

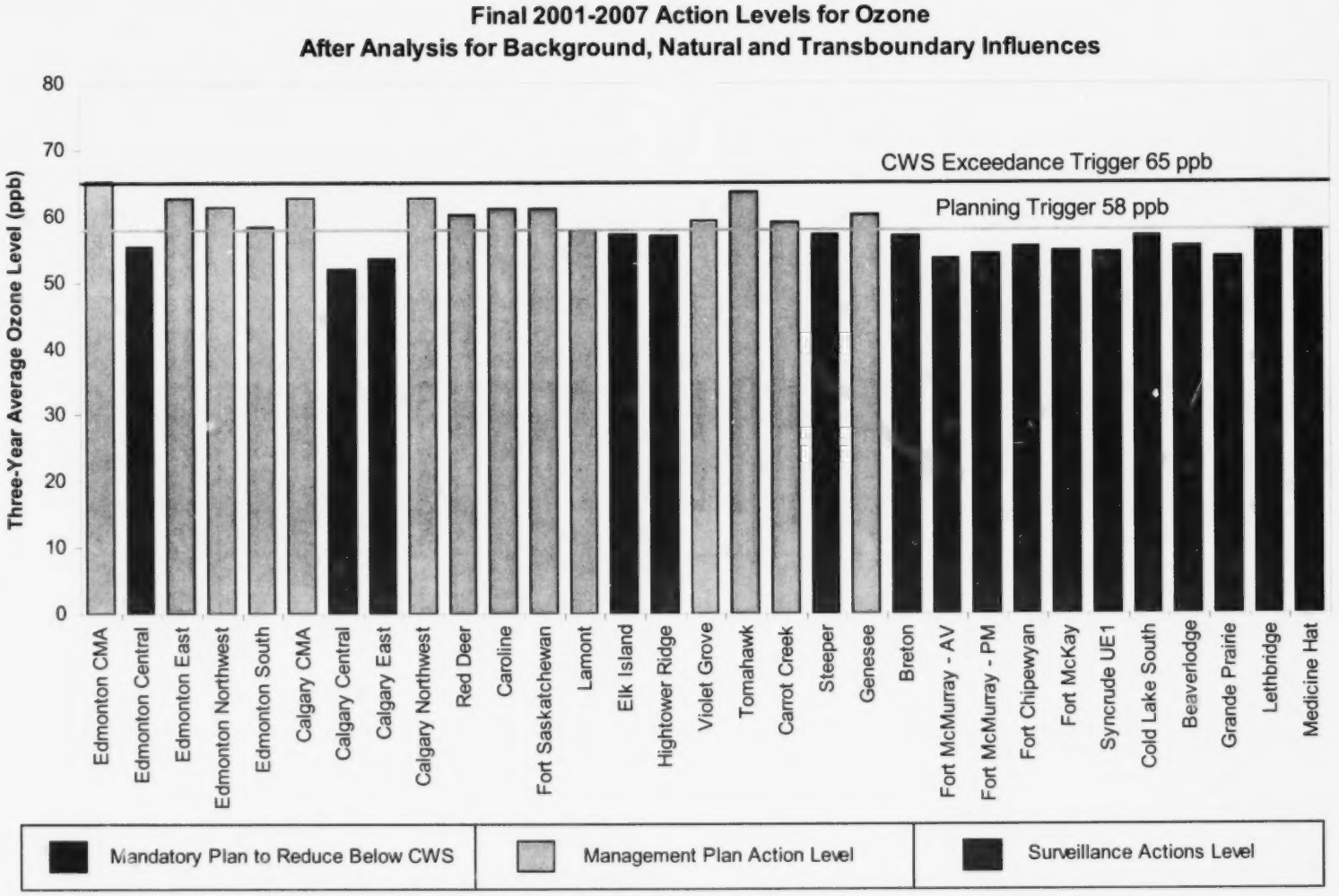


Figure 19 Final Assessment Results for Ozone in Alberta over 2001-2007.

Table 2 Final $PM_{2.5}$ Action Levels by Area.

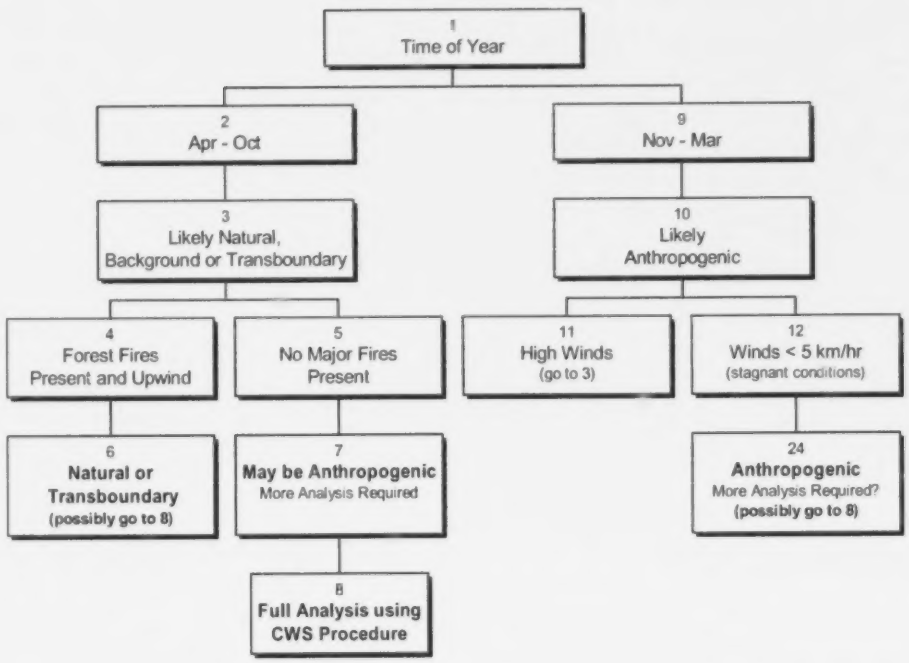
	Baseline Monitoring Action Level		*Surveillance Actions* Action Level	*Management Plan* Action Level
Stations	Edmonton South Calgary Northwest Red Deer Hightower Ridge Tomahawk Genesee Powers Edson Fort McMurray – AV Fort McMurray – PM Fort Chipewyan	Fort McKay Albian Mine Site Millennium Syncrude UE1 Cold Lake South Beaverlode Grande Prairie Evergreen Park Smokey Heights Lethbridge Medicine Hat	Edmonton CMA Edmonton Central Edmonton East Calgary CMA Calgary Central Calgary East Lamont Elk Island Redwater Drayton Valley	Edmonton Northwest* Fort Saskatchewan*
Airsheds	PAMZ WBEA LICA PASZA PAS		Edmonton (ACAA) Calgary (CRAZ) FAP WCAS	none

*Not representative due to limited data (Fort Saskatchewan) and interference from nearby construction (Edmonton Northwest).

Table 3 Final Ozone Action Levels by Area.

	Surveillance Actions Action Level		*Management Plan* Action Level	
Stations	Edmonton Central Calgary Central Calgary East Elk Island Hightower Ridge Steeper Breton Fort McMurray – AV Fort McMurray – PM	Fort Chipewyan Fort McKay Syncrude UE1 Cold Lake South Beaverlode Grande Prairie Lethbridge Medicine Hat	Edmonton CMA Edmonton East Edmonton Northwest Edmonton South Calgary CMA Calgary Northwest Red Deer	Caroline Fort Saskatchewan Lamont Violet Grove Tomahawk Carrot Creek Genesee
Airsheds	WBEA LICA PASZA PAS		Edmonton (ACAA) Calgary (CRAZ) PAMZ FAP WCAS	

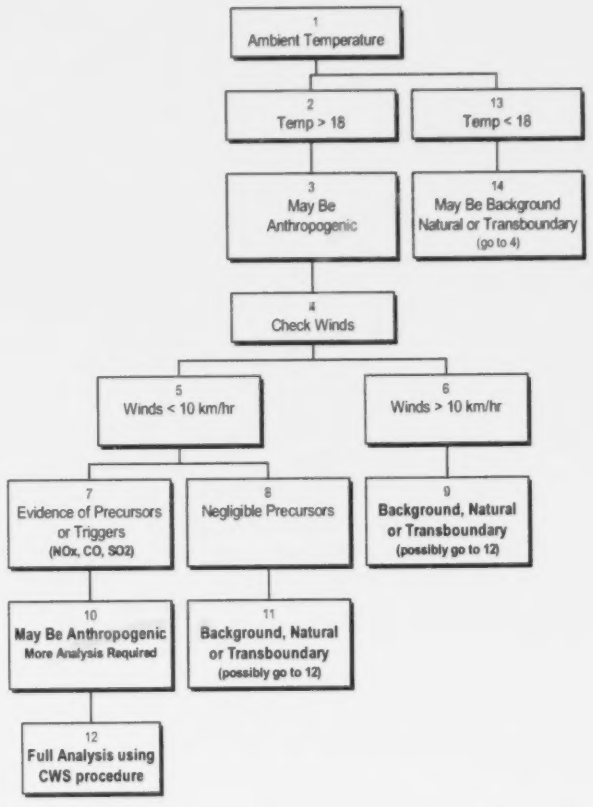
APPENDIX



* **Disclaimer:** This flow chart is meant only as a guide. It is not intended to give conclusive results, but to be used along with understanding of the data, location, and specific circumstances surrounding each episode.

Note: Prior to this analysis, the exceedance date would be compared to episodes already analyzed for the CWS trigger. Some episodes may warrant further analysis (back trajectory, analysis of upwind stations, etc.). Conclusions may depend on where the episode occurs (i.e., urban versus rural) as well as the spatial extent of the episode.

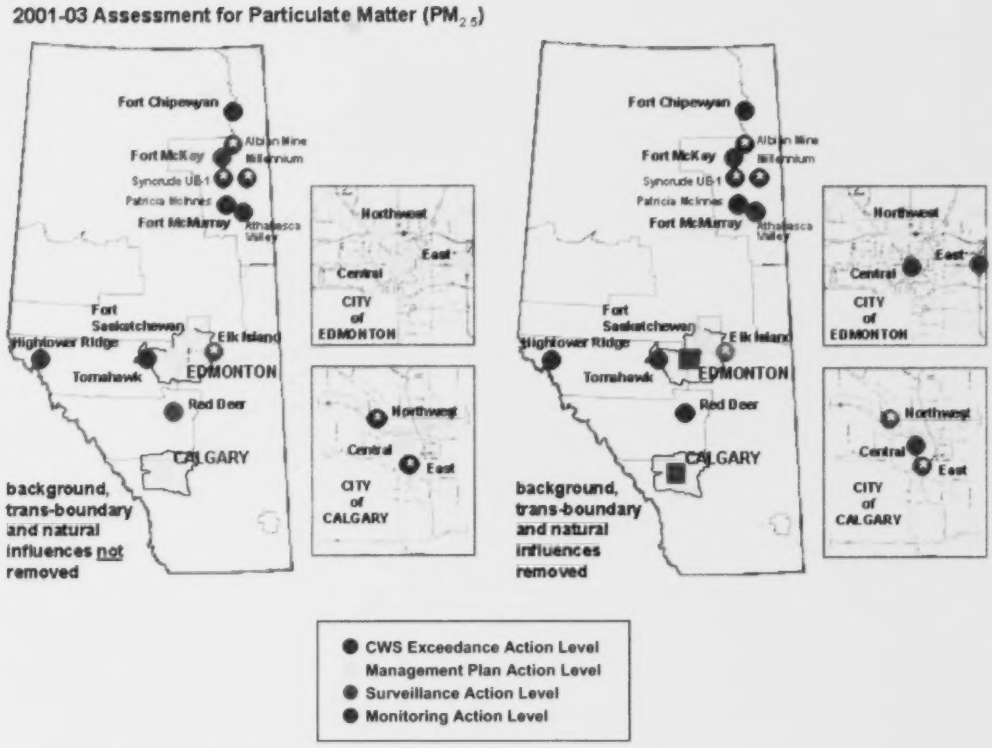
Figure A1 Simplified procedure for evaluating exceedances of the $PM_{2.5}$ planning and surveillance triggers.



* **Disclaimer:** This flow chart is meant only as a guide. It is not intended to give conclusive results, but to be used along with understanding of the data, location, and specific circumstances surrounding each episode.

Note: Prior to this analysis, the exceedance date would be compared to episodes already analyzed for the CWS trigger. Some episodes may warrant further analysis (back trajectory, analysis of upwind stations, etc.). Conclusions may depend on where the episode occurs (i.e., urban versus rural) as well as the spatial extent of the episode.

Figure A2 Simplified procedure for evaluating exceedances of the ozone planning trigger.



Squares represents the Edmonton and Calgary Census Metropolitan Areas (CMAs).
Asterisk (*) indicates incomplete data set.

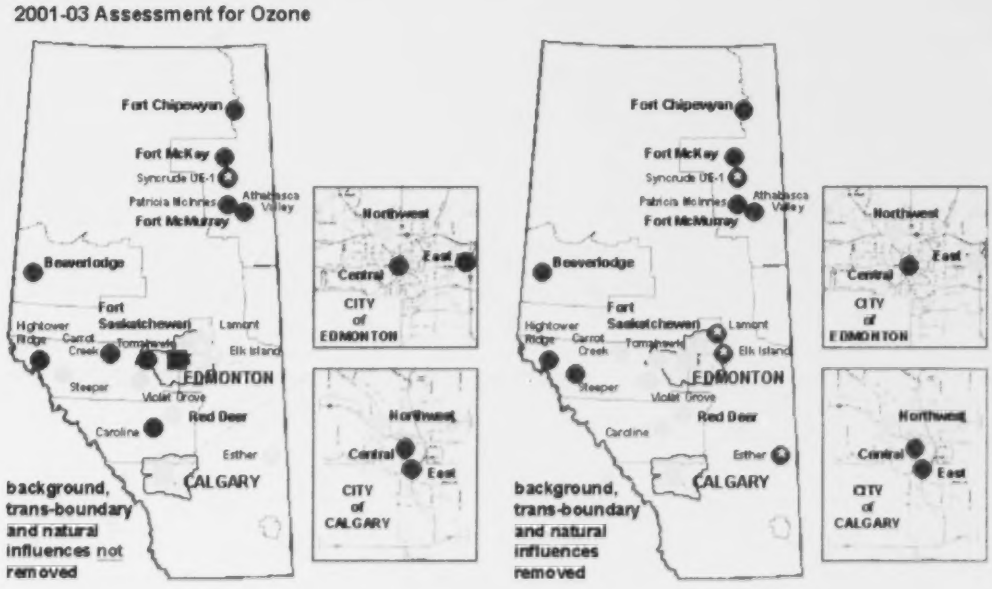
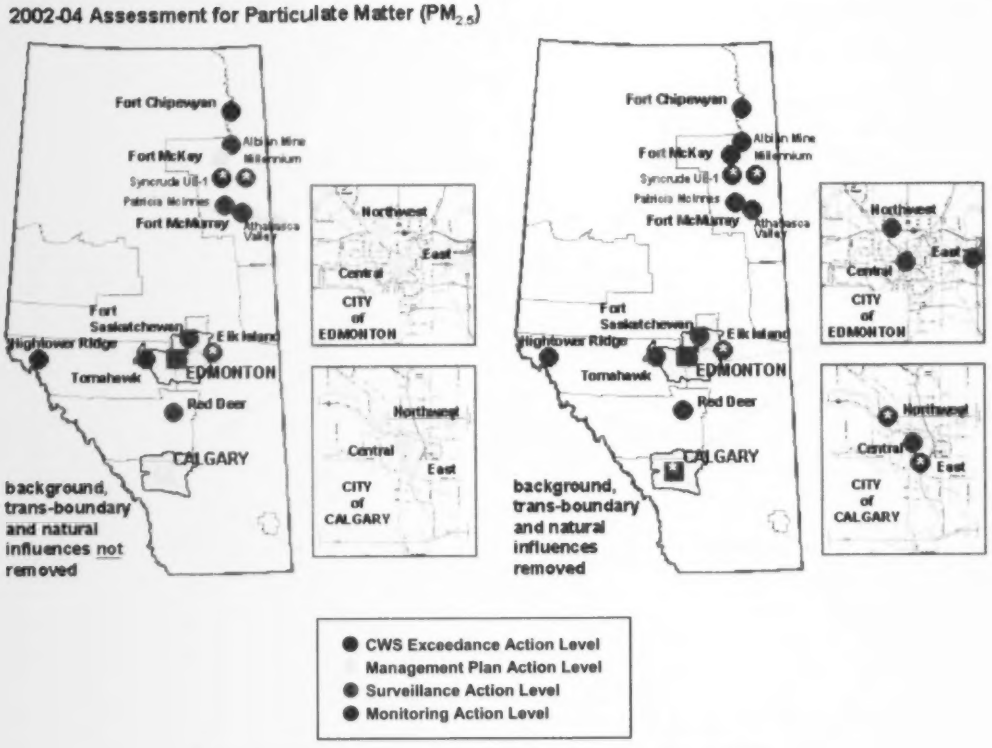


Figure A3 2001 – 2003 particulate matter and ozone assessment action levels.



Squares represents the Edmonton and Calgary Census Metropolitan Areas (CMAs).
Asterisk (*) indicates incomplete data set.

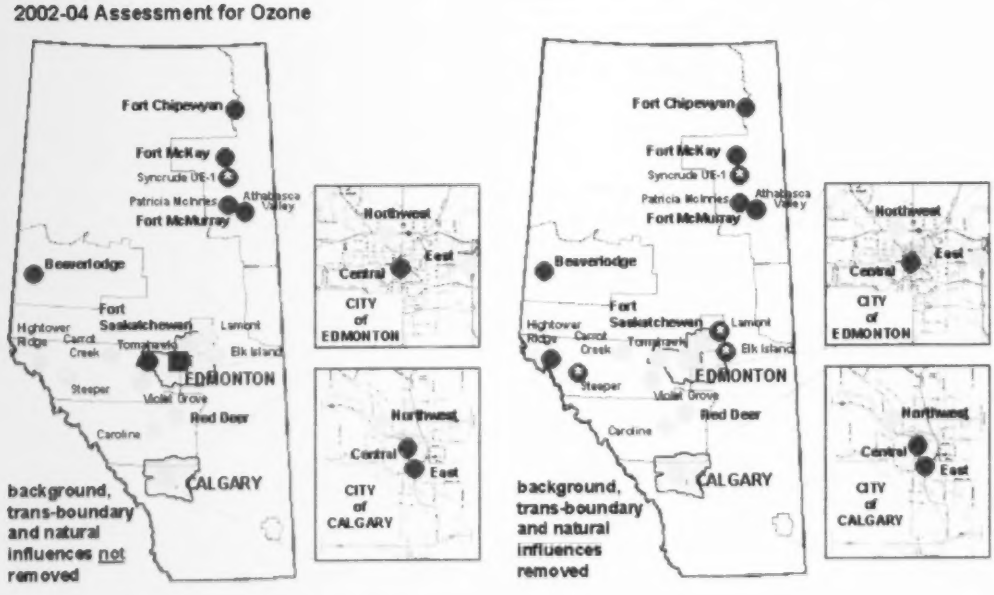
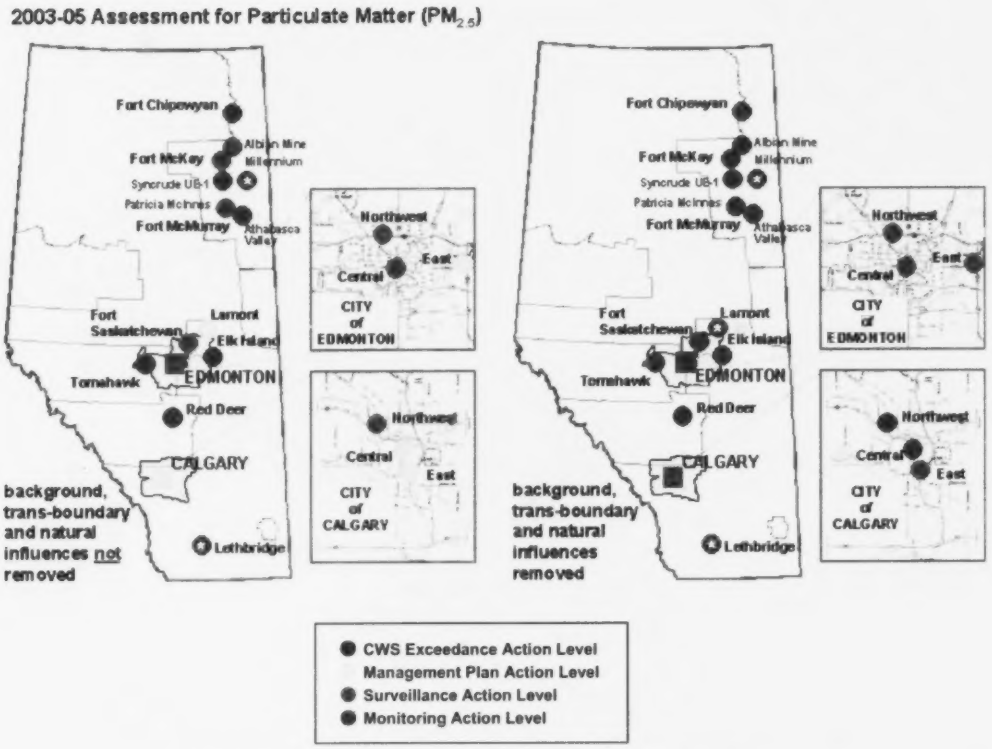


Figure A4 2002 – 2004 particulate matter and ozone assessment action levels.



Squares represents the Edmonton and Calgary Census Metropolitan Areas (CMAs).
Asterisk (*) indicates incomplete data set

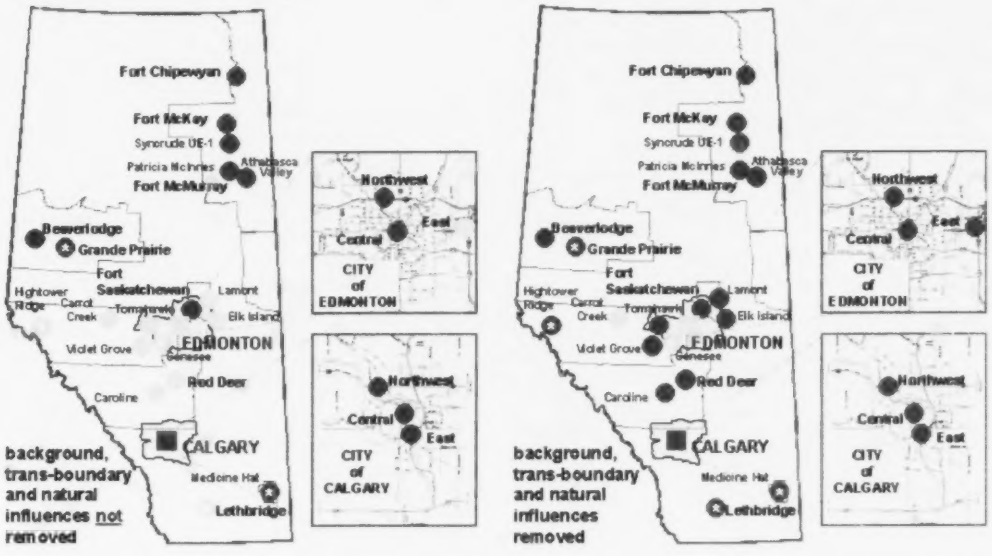
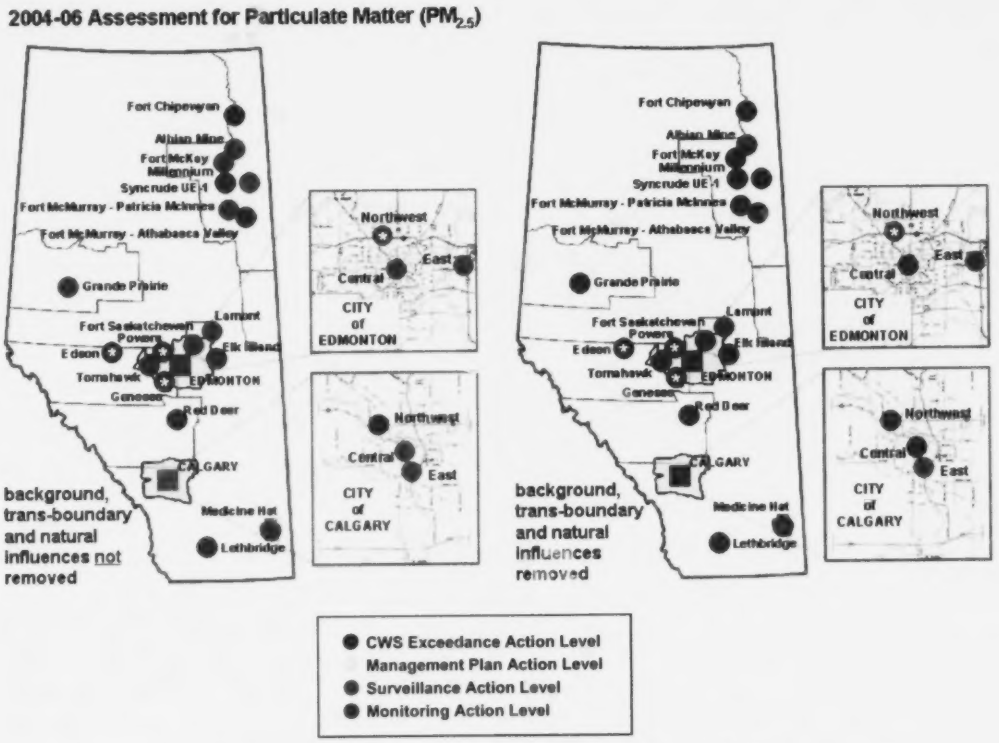


Figure A5 2003 – 2005 particulate matter and ozone assessment action levels.



Squares represents the Edmonton and Calgary Census Metropolitan Areas (CMAs).
Asterisk (*) indicates incomplete data set.

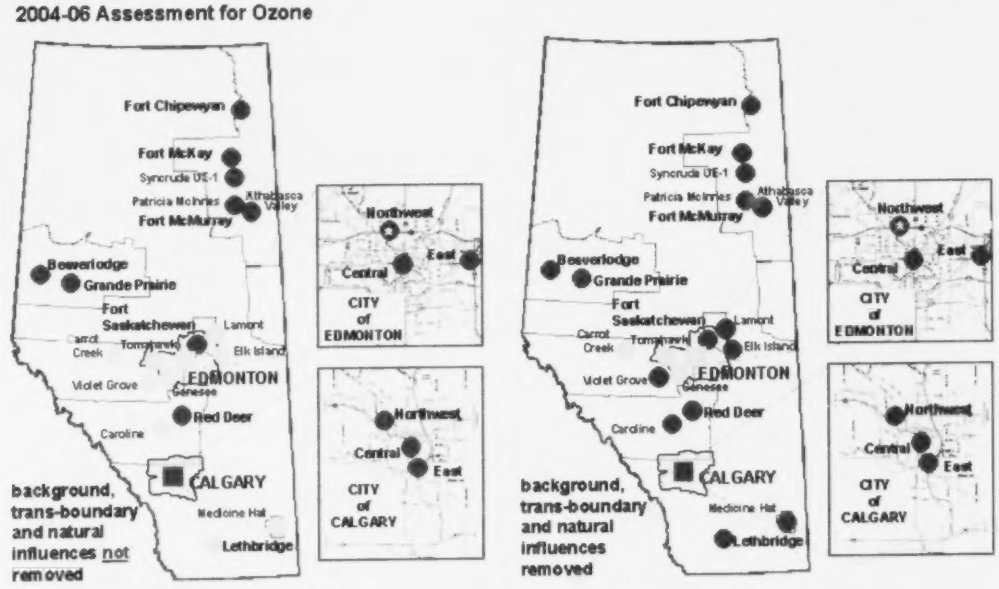
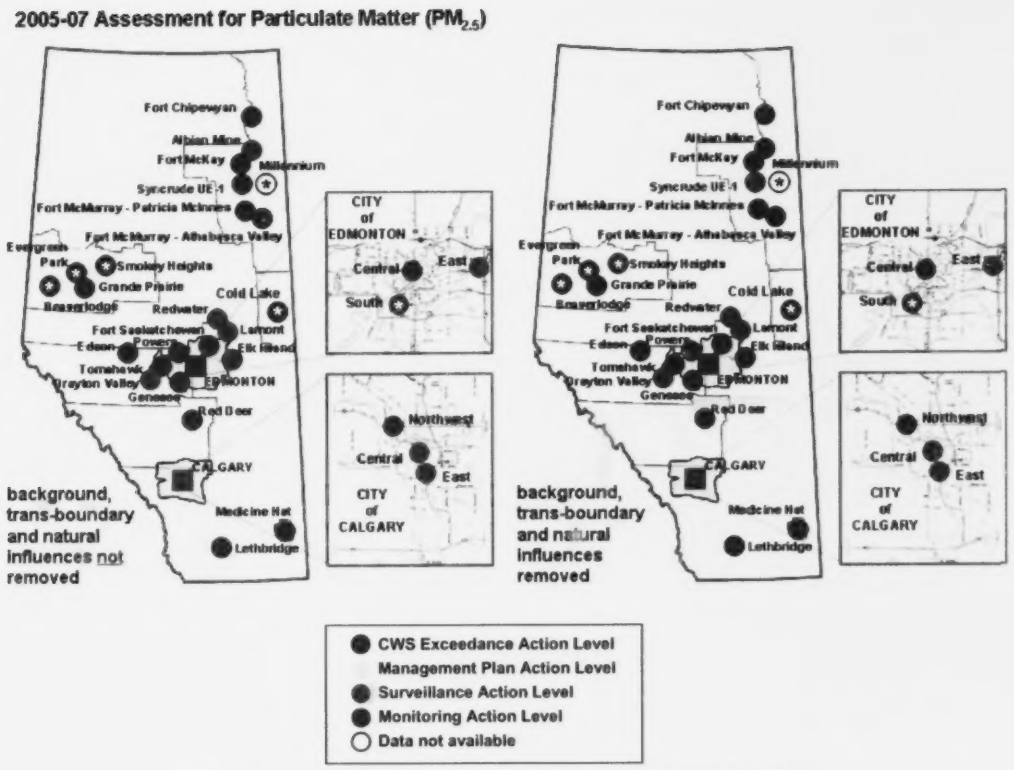


Figure A6 2004 – 2006 particulate matter and ozone assessment action levels.



Squares represents the Edmonton and Calgary Census Metropolitan Areas (CMAs).
Asterisk (*) indicates incomplete data set.

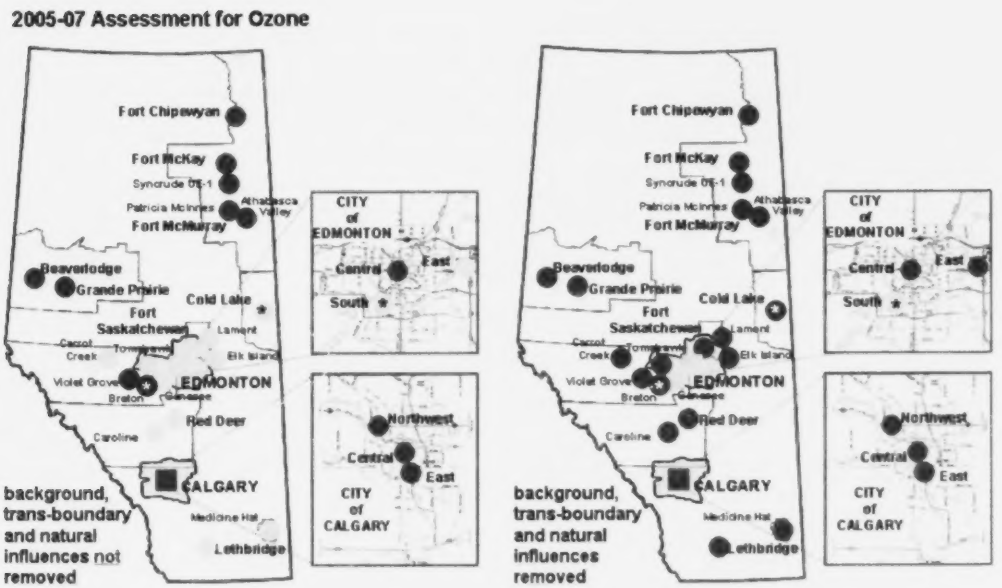


Figure A7 2004 – 2006 particulate matter and ozone assessment action levels.

Table A1 Annual and 3-year average $PM_{2.5}$ levels ($\mu g/m^3$) *before* backing out (2001-2007).

Station	Annual 98th percentiles ($\mu g/m^3$)							Three-Year Averages					Data Completeness* by year and quarter																			
													2001				2002				2003				2004				2005				2006				2007			
	2001	2002	2003	2004	2005	2006	2007	01-03	02-04	03-05	04-06	05-07	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Edmonton CMA					10.4	14.3	12.6				14.1	12.5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Edmonton Central					12.9		13.4					14.4	100	97	100	96	99	98	100	100	100	96	100	100	97	99	100	100	100	100	100	100	98	96	98	100	99	100	96	98
Edmonton East													100	100	100	99	100	99	100	99	100	99	90	98	100	100	97	100	100	98	95	93	98	97	100	100	100	100	97	88
Edmonton Northwest					14.2								99	92	100	100	97	100	100	98	99	100	100	100	97	100	98	100	100	99	100	78	0	0	0	0	0	0	0	0
Edmonton South					13.1								0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	97	98	100	100	100	100	100	100	72
Calgary CMA			34.7		13.3								100	100	99	100	100	100	99	99	99	100	100	100	100	100	100	100	100	100	100	100	99	100	100	99	100	100	100	100
Calgary Central			33.6		13.3								100	100	99	100	100	100	99	99	99	100	100	100	95	100	100	100	100	100	100	100	96	100	99	99	99	100	99	98
Calgary East			38.7										0	0	0	0	0	0	0	59	99	97	100	74	100	100	100	100	100	97	99	100	99	91	100	99	99	98	84	90
Calgary Northwest		13.8	33.4	13.4	10.3		14.9				13.4	13.9	0	0	0	0	0	0	0	60	98	96	96	100	100	100	96	98	100	100	100	100	97	100	100	99	100	91	100	100
Red Deer				13.7	10.0	14.5	11.8			14.8	12.7	12.1	90	100	99	91	96	99	100	100	100	99	99	100	99	99	100	99	97	88	100	100	100	99	99	98	99	100	100	95
Fort Saskatchewan	43.0				14.9		13.1					14.5	0	0	0	66	100	98	97	100	99	99	100	100	100	100	97	100	100	89	100	100	99	100	98	97	100	100	100	96
Lamont													0	0	0	0	0	0	0	0	100	93	55	75	90	99	98	98	96	97	90	96	99	98	91	100	96	93	98	95
Elk Island				14.2	9.5	11.9				14.3	11.9	14.2	0	0	0	0	0	0	0	0	99	87	99	100	99	100	99	99	100	100	96	100	97	98	100	100	97	98	100	100
Redwater													0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	100	100	100	100	100	100	100	100	99	99	99
Hightower Ridge	9.5	8.0		11.9			4.6	10.9	11.6				100	100	100	93	93	98	98	100	83	100	97	99	99	96	97	0	0	0	0	0	0	0	0	0	0	0	0	26
Tomahawk		13.8	14.5		8.9	13.3	11.9	14.4	15.0	13.3	12.9	11.4	98	97	90	90	100	98	99	100	100	87	95	99	99	91	90	97	100	89	99	100	99	99	100	100	98	98	100	100
Genesee					8.3	13.4	11.5				10.9	11.1	0	0	0	0	0	0	0	0	0	0	0	0	0	65	97	99	100	100	97	100	97	96	99	98	100	100	89	99
Powers					9.0	13.7	12.0				11.3	11.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98	98	100	100	99	100	100	98	99	99	100	100	99	100
Drayton Valley					14.4								0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	98	100	100	100	91	99	100	100	97	100	100
Edson				7.9	10.1	14.5	12.0				12.3	12.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66	100	100	100	98	100	93	98	100	98	100	100	98
Fort McMurray - AV			11.3		12.7	15.0							93	100	100	100	100	100	88	100	100	100	98	100	97	99	100	100	98	100	95	98	96	100	98	97	90	99	98	100
Fort McMurray - PM	14.3	14.2	11.6		9.4	13.1	13.2	15.0	14.5	13.4	14.6	14.8	98	99	100	100	100	99	92	99	100	99	97	100	80	99	100	99	99	49	100	100	96	89	98	95	98	90	98	99
Fort Chipewyan	7.6	11.0	7.8	13.6	12.2	10.5	10.2	7.7	10.7	11.2	12.1	10.9	99	99	100	100	100	100	91	75	96	99	99	100	100	96	100	97	98	98	99	98	97	100	100	100	93	97	97	100
Fort McKay	14.6					13.3						15.0	100	98	100	99	99	98	85	99	98	100	99	100	100	100	98	100	100	98	98	100	100	95	99	99	98	97	98	99
Albian Mine Site			12.7										0	0	99	100	96	87	88	99	90	100	99	100	100	99	100	100	99	100	97	98	99	87	93	89	78	100	93	100
Millennium	10.7	12.6	7.5										0	0	33	93	82	97	78	87	39	0	0	0	98	99	100	100	100	100	98	97	100	100	91	53	0	86	96	100
Syncrude UE1		10.9	12.8	13.5	13.0	13.3			13.1	13.1	13.3	13.9	0	0	0	0	0	0	33	100	94	97	100	98	100	100	99	100	99	98	100	100	100	96	98	100	98	98	97	98
Cold Lake South						11.0	9.2					10.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97	92	97	95	99	100	98	99
Beaverlodge					10.0	13.1	10.1					11.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78	98	99	96	99	98	100	99	98	100	99
Grande Prairie					14.7		11.9					14.3	0	0	0	0	0	0	0	0	0	0	0	0	54	99	96	100	99	98	100	97	100	100	100	95				
Evergreen Park					11.4		12.0					13.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	99	100	99	97	98	100	91	94	99	100	100
Smokey Heights					11.5	14.7	9.4					12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	93	99	93	82	92	100	100	97	98	100
Lethbridge			13.6	14.2	10.0	12.3	12.1			12.1	12.2	11.5	0	0	0	0	0	0	0	0	0	0	0	97	98	100	99	100	96	100	100	100	98	100	100	100	100	100	100	100
Medicine Hat					8.7	9.5	10.5				9.1	9.6	0	0	0	0	0	0	0	0	0	0	0	0	74	97	99	100	98	90	97	100	100	99	93	97	100	100	96	95

*A year's data is considered "complete" if valid 24-hour averages are available for 75% of each quarter of the year.

Exceeds CWS Trigger

Exceeds Planning Trigger

Exceeds Surveillance Trigger

Below Surveillance Trigger

Table A2 Annual and 3-year average $PM_{2.5}$ levels ($\mu g/m^3$) *after* backing out (2001-2007).

Station	Annual 98th percentiles ($\mu g/m^3$)							Three-Year Averages					Data Completeness* by year and quarter																			
													2001				2002				2003				2004				2005				2006				2007			
	2001	2002	2003	2004	2005	2006	2007	01-03	02-04	03-05	04-06	05-07	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Edmonton CMA	21.2	17.7	18.1	15.9	10.3	14.3	12.6	19.0	17.2	14.8	13.5	12.4	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Edmonton Central	18.0	16.8	18.4	15.8	12.9	15.4	13.4	17.7	17.0	15.7	14.7	13.9	100	97	100	96	99	98	100	100	100	96	100	100	97	99	100	100	100	100	100	100	98	96	98	100	99	100	96	98
Edmonton East	20.4	20.3	18.8	15.6	15.2	18.0	15.5	19.8	18.2	16.5	16.3	16.2	100	100	100	99	100	99	100	99	100	99	90	98	100	100	97	100	100	98	95	93	98	97	100	100	100	100	97	88
Edmonton Northwest	28.6	20.3	20.1	17.5	14.2			23.0	19.3	17.3	15.9		99	92	100	100	97	100	100	98	99	100	100	100	97	100	98	100	100	99	100	78	0	0	0	0	0	0	0	0
Edmonton South					13.1	14.3	15.5					14.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	97	98	100	100	100	100	100	100	72
Calgary CMA	18.1	17.1	17.2	17.4	13.3	13.9	15.5	17.5	17.2	16.0	14.9	14.4	100	100	99	100	100	100	99	99	99	100	100	100	100	100	100	100	100	100	100	100	99	100	100	99	100	100	100	100
Calgary Central	18.1	17.8	16.9	13.4	13.3	14.3	15.3	17.6	16.0	14.5	13.6	14.3	100	100	99	100	100	100	99	99	99	100	100	100	95	100	100	100	100	100	100	100	96	100	99	99	99	100	99	98
Calgary East		16.6	16.9	16.1	15.1	15.6	18.0			16.6	16.3	16.2	0	0	0	0	0	0	0	59	99	97	100	74	100	100	100	100	100	97	99	100	99	91	100	99	99	98	84	90
Calgary Northwest		13.8	16.1	13.4	10.3	12.6	14.9		14.8	13.3	12.1	12.6	0	0	0	0	0	0	0	60	98	96	96	100	100	100	96	98	100	100	100	100	97	100	100	99	100	91	100	100
Red Deer	15.0	15.1	11.4	13.7	10.0	14.5	11.8	13.8	13.4	11.7	12.7	12.1	90	100	99	91	96	99	100	100	100	99	99	100	99	99	100	99	97	88	100	100	100	99	99	98	99	100	100	95
Fort Saskatchewan	43.0	16.7	15.0	14.2	14.9	13.5	13.1	24.1	15.3	14.7	14.2	13.8	0	0	0	66	100	98	97	100	99	99	100	100	100	100	97	100	100	89	100	100	99	100	98	97	100	100	100	96
Lamont			24.4	20.1	17.1	16.4	16.0			18.6	17.9	16.5	0	0	0	0	0	0	0	0	100	93	55	75	90	99	98	98	96	97	90	96	99	98	91	100	96	93	98	95
Elk Island			17.4	14.2	9.5	11.9	18.6		15.8	13.7	11.9	13.3	0	0	0	0	0	0	0	0	99	87	99	100	99	100	99	100	100	99	99	99	100	100	96	100	97	98	100	100
Redwater					15.5	18.8	15.0					16.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	100	100	100	100	100	100	100	100	99	99	99
Hightower Ridge	9.5	8.0	15.3	11.9			4.6	10.9	11.6				100	100	100	93	93	98	98	100	83	100	97	99	99	96	97	0	0	0	0	0	0	0	0	0	0	0	0	26
Tomahawk	15.1	13.8	14.5	12.9	8.9	13.3	11.9	14.4	13.7	12.1	11.7	11.4	98	97	90	90	100	98	99	100	100	87	95	99	99	91	90	97	100	89	99	100	99	99	100	100	98	98	100	100
Genesee				16.7	8.3	13.4	11.5				10.9	11.1	0	0	0	0	0	0	0	0	0	0	0	0	0	65	97	99	100	100	97	100	97	96	99	98	100	100	89	99
Powers				18.1	9.0	13.7	12.0				11.3	11.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98	98	100	100	99	100	100	98	99	99	100	100	99	100
Drayton Valley					14.4	16.8	15.2					15.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	98	100	100	100	91	99	100	100	97	100	100
Edson				7.9	10.1	14.5	12.0				12.3	12.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66	100	100	100	98	100	93	98	100	98	100	100	98
Fort McMurray - AV	17.5	16.2	11.3	11.1	12.7	15.0	14.2	15.0	12.9	11.7	12.9	13.9	93	100	100	100	100	100	88	100	100	100	98	100	97	99	100	100	98	100	95	98	96	100	98	97	90	99	98	100
Fort McMurray - PM	14.3	14.2	11.6	11.4	9.4	13.1	13.2	13.3	12.4	11.5	12.2	13.2	98	99	100	100	100	99	92	99	100	99	97	100	80	99	100	99	99	49	100	100	96	89	98	95	98	90	98	99
Fort Chipewyan	7.6	11.0	7.8	13.6	12.2	10.5	10.2	7.7	10.7	11.2	12.1	10.9	99	99	100	100	100	100	91	75	96	99	99	100	100	96	100	97	98	98	99	98	97	100	100	100	93	97	97	100
Fort McKay	14.6	12.7	14.8	9.4	12.5	13.3	14.6	14.0	12.3	12.2	11.7	13.5	100	98	100	99	99	98	85	99	98	100	99	100	100	100	98	100	100	98	98	100	100	95	99	99	98	97	98	99
Albian Mine Site	17.5	12.1	12.7	11.0	11.7	12.8	14.9	12.4	11.9	11.8	11.8	13.1	0	0	99	100	96	87	88	99	90	100	99	100	100	99	100	100	99	100	97	98	99	87	93	89	78	100	93	100
Millennium	10.7	12.6	7.5	11.8	14.3	17.0	18.8		12.2	13.1	13.1		0	0	33	93	82	97	78	87	39	0	0	0	98	99	100	100	100	100	98	97	100	100	91	53	0	86	96	100
Syncrude UE1		10.9	12.8	13.5	13.0	13.3	12.1		13.1	13.1	13.3	12.8	0	0	0	0	0	0	33	100	94	97	100	98	100	100	99	100	99	98	100	100	100	96	98	100	98	98	97	98
Cold Lake South						11.0	9.2					10.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97	92	97	95	99	100	98	99				
Beaverlodge					10.0	13.1	10.1					11.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78	98	99	96	99	98	100	99	98	100	99
Grande Prairie				17.4	14.7	14.3	11.9				14.5	13.6	0	0	0	0	0	0	0	0	0	0	0	0	54	99	96	100	100	98	100	100	99	98	100	97	100	100	100	95
Evergreen Park					11.4	13.1	12.0					12.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	99	100	99	97	98	100	91	94	99	100	100
Smokey Heights					11.5	14.7	9.4					12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	93	99	93	82	92	100	100	97	98	100
Lethbridge			13.6	14.2	10.0	12.3	12.1			12.1	12.2	11.5	0	0	0	0	0	0	0	0	0	0	0	97	98	100	99	100	96	100	100	100	98	100	100	100	100	100	100	100
Medicine Hat				15.8	8.7	9.5	10.5				9.1	9.6	0	0	0	0	0	0	0	0	0	0	0	0	74	97	99	100	98	90	97	100	100	99	93	97	100	100	96	95

*A year's data is considered "complete" if a valid 24-hour averages are available for 75% of each quarter of the year.

Exceeds CWS Trigger

Exceeds Surveillance Trigger

Exceeds Planning Trigger

Below Surveillance Trigger

Table A3 Annual and 3-year average ozone levels (ppb) *before* backing out (2001-2007).

Site	4th Highest Annual Value (ppb)							Data Completeness* by year							Three-Year Average (ppb)				
	2001	2002	2003	2004	2005	2006	2007	2001	2002	2003	2004	2005	2006	2007	01-03	02-04	03-05	04-06	05-07
Edmonton CMA	64.3	**74.0**	**68.1**	62.5	60.3	**68.1**	**66.8**								**68.8**	**68.2**	63.6	63.6	65.1
Edmonton Central	49.5	62.5	52.0	51.9	50.8	50.6	52.8	98	100	100	100	99	100	100	54.7	55.5	51.6	51.1	51.4
Edmonton East	64.3	**69.5**	63.9	60.9	50.9	60.3	63.1	96	99	97	99	99	99	99	**65.9**	64.8	58.6	57.4	58.1
Edmonton Northwest	58.6	**69.3**	65.4	55.9	51.0			95	100	98	99	98			64.4	63.5	57.4	53.5	
Edmonton South					36.5	61.9	64.8					5	99	100					63.4
Calgary CMA	58.8	**69.1**	63.3	57.6	51.9	57.0	59.0								63.7	63.3	57.6	55.5	56.0
Calgary Central	51.5	52.0	52.5	47.5	45.9	48.9	51.6	100	99	100	100	98	99	99	52.0	50.7	48.6	47.4	48.8
Calgary East	53.5	53.8	53.0	53.9	47.9	56.6	55.6	99	97	99	99	96	98	100	53.4	53.6	51.6	52.8	53.4
Calgary Northwest	58.8	**69.1**	63.3	57.6	51.9	57.0	59.0	100	99	100	98	100	99	96	63.7	63.3	57.6	55.5	56.0
Red Deer	57.9	**67.0**	63.9	55.3	55.4	60.3	61.8	97	96	99	99	92	96	97	62.9	62.1	58.2	57.0	59.2
Caroline	**66.3**	**68.0**	**70.5**	53.4	61.4	63.5	60.8	97	98	95	80	95	96	96	**68.3**	64.0	61.8	59.4	61.9
Fort Saskatchewan	62.5	**69.8**	55.8	56.6	53.5	61.9	62.8	99	96	100	100	97	100	100	62.7	60.7	55.3	57.3	59.4
Lamont			61.9	60.6	56.1	**66.9**	58.9			99	97	97	98	97		61.3	59.5	61.2	60.6
Elk Island			59.1	59.0	59.3	61.4	58.1			98	98	96	99	98		59.1	59.1	59.9	59.6
Hightower Ridge	**73.4**	64.3	61.4	**66.0**			52.8	97	93	97	96				**66.4**	63.9	63.7		
Violet Grove	61.3	**67.1**	65.3	59.5	63.9	**67.5**	**65.5**	95	90	97	96	96	93	97	64.6	64.0	62.9	63.6	**65.6**
Tomahawk	60.1	**74.0**	**68.1**	60.9	60.3	**66.0**	63.0	92	96	90	96	91	95	96	**67.4**	**67.7**	63.1	62.4	63.1
Carrot Creek	**68.3**	**65.5**	**66.1**	59.6	58.8	**68.5**	63.8	96	97	96	94	96	96	96	**66.6**	63.7	61.5	62.3	63.7
Steeper	**66.0**	60.3	**66.9**					93	91	78					64.4	63.6			
Genesee				62.5	57.4	**68.1**	**66.8**				93	95	95	93			60.0	62.7	64.1
Breton						65.1	**67.5**						92	96					**66.3**
Fort McMurray - AV	49.3	54.0	56.0	50.3	52.3	55.1	52.9	96	96	96	96	97	96	95	53.1	53.4	52.9	53.6	54.4
Fort McMurray - PM	54.0	55.6	53.3	47.8	53.5	54.8	52.4	97	97	96	97	96	96	97	54.3	52.2	51.5	52.0	53.6
Fort Chipewyan	49.4	54.6	54.8	56.5	49.6	53.0	51.5	97	98	96	97	97	97	85	54.8	55.3	53.6	53.0	51.4
Fort McKay	50.4	50.9	61.7	48.0	54.6	61.8	54.9	94	96	94	97	95	90	95	54.3	53.5	54.8	54.8	57.1
Syncrude UE1		32.0	57.5	49.9	51.4	59.0	57.0		16	93	97	96	92	94		53.7	52.9	53.4	55.8
Cold Lake South						59.0	58.1						91	95					58.1
Beaverlodge	62.0	49.5	54.6	55.3	53.6	58.6	58.6	85	99	98	99	99	96	98	55.4	53.1	54.5	55.9	57.0
Grande Prairie				56.4	51.3	53.0	51.5				98	97	81	97			53.9	53.6	51.9
Lethbridge			42.0	59.5	57.1	62.0	60.4				98	99	99	99			58.2	59.7	60.1
Medicine Hat				61.3	53.6	60.9	64.1				96	96	97	95			57.5	58.6	59.5

*A year's data is considered "complete" if a valid daily maximum 8-hour average is available for 75% of the days in the 2nd and 3rd quarters of the year (the months of April through September inclusive).

Mandatory Plan to Reduce Below CWS Action Level

Management Planning Action Level

Surveillance Actions Action Level

Table A4 Annual and 3-year average ozone levels (ppb) *after* backing out (2001-2007).

Site	4th Highest Annual Value (ppb)							Data Completeness* by year							Three-Year Average (ppb)				
	2001	2002	2003	2004	2005	2006	2007	2001	2002	2003	2004	2005	2006	2007	01-03	02-04	03-05	04-06	05-07
Edmonton CMA	60.0	**74.0**	58.9	62.5	57.4	60.4	60.1								64.3	65.1	59.0	60.1	59.2
Edmonton Central	49.5	62.5	52.0	51.9	50.8	50.6	52.8	98	100	100	100	99	100	100	54.7	55.5	51.6	51.1	51.4
Edmonton East	59.9	**69.5**	57.4	60.9	50.9	57.0	57.0	96	99	97	99	99	99	99	62.3	67.6	56.4	56.3	55.0
Edmonton Northwest	54.6	**69.3**	58.9	55.9	51.0			95	100	98	99	98			60.9	61.4	55.3	53.5	
Edmonton South					36.5	57.5	59.1					5	99	100					58.2
Calgary CMA	57.4	**69.1**	61.4	57.6	51.9	57.0	57.3								62.6	62.7	57.0	55.5	55.4
Calgary Central	51.5	52.0	52.5	47.5	45.9	48.9	51.6	100	99	100	100	98	99	99	52.0	50.7	48.6	47.4	48.8
Calgary East	53.5	53.8	53.0	53.9	47.9	56.6	55.6	99	97	99	99	96	98	100	53.4	53.6	51.6	52.8	53.4
Calgary Northwest	57.4	**69.1**	61.4	57.6	51.9	57.0	57.3	100	99	100	98	100	99	96	62.6	62.7	57.0	55.5	55.4
Red Deer	55.9	**67.0**	57.3	55.3	55.4	57.1	57.6	97	96	99	99	92	96	97	60.1	59.9	56.0	55.9	56.7
Caroline	62.4	62.0	58.6	53.4	59.8	56.4	57.8	97	98	95	80	95	96	96	61.1	58.1	57.3	56.5	58.0
Fort Saskatchewan	57.6	**69.8**	55.8	56.6	53.5	56.6	56.9	99	96	100	100	97	100	100	61.1	60.7	55.3	55.6	55.7
Lamont			56.1	59.4	56.1	58.5	55.9			99	97	97	98	97		57.8	57.2	58.0	56.8
Elk Island			55.3	59.0	55.3	57.3	55.3			98	98	96	99	98		57.2	56.5	57.2	56.0
Hightower Ridge	57.6	57.0	56.6	57.0			52.8	97	93	97	96				57.1	56.9	56.6		
Violet Grove	57.0	62.0	57.6	58.0	57.5	57.1	56.9	95	90	97	96	96	93	97	58.9	59.2	57.7	57.5	57.2
Tomahawk	60.0	**74.0**	56.3	60.8	57.0	56.6	57.0	92	96	90	96	91	95	96	63.4	63.7	58.0	58.1	56.9
Carrot Creek	57.4	61.5	56.2	59.6	58.5	56.8	57.0	96	97	96	94	96	96	96	58.4	58.1	58.1	58.3	57.4
Steeper	56.9	57.3	57.1					93	91	78					57.1	57.2			
Genesee				62.5	57.4	60.4	60.1				93	95	95	93			60.0	60.1	59.3
Breton						56.5	57.6						92	96					57.1
Fort McMurray - AV	49.3	54.0	56.0	50.3	52.3	55.8	52.9	96	96	96	96	97	96	95	53.1	53.4	52.9	52.8	53.7
Fort McMurray - PM	54.0	55.6	53.3	47.8	53.9	54.8	52.4	97	97	96	97	96	96	97	54.3	52.2	51.5	52.0	53.6
Fort Chipewyan	49.4	54.6	54.8	56.3	49.6	53.0	51.3	97	98	96	97	97	97	85	54.8	55.3	53.6	53.0	51.4
Fort McKay	50.4	50.9	51.7	48.0	54.6	53.6	54.9	94	96	94	97	95	90	95	54.3	53.5	54.8	52.1	54.4
Syncrude UE1		32.0	57.5	49.9	51.4	55.3	57.0		16	93	97	96	92	94		53.7	52.9	52.2	54.6
Cold Lake South						57.0	57.1						91	95					57.1
Beaverlodge	62.0	49.5	54.6	55.3	53.6	56.0	55.5	85	99	98	99	99	96	98	55.4	53.1	54.5	55.0	55.0
Grande Prairie				56.4	51.3	53.0	51.5				98	97	81	97			53.9	53.6	51.9
Lethbridge			42.0	58.3	57.1	54.5	59.8				98	99	99	99			57.7	56.6	57.1
Medicine Hat				53.3	53.6	56.8	52.4				96	96	97	95			57.5	57.2	57.6

*A year's data is considered "complete" if a valid daily maximum 8-hour average is available for 75% of the days in the 2nd and 3rd quarters of the year (the months of April through September inclusive).

Mandatory Plan to Reduce Below CWS Action Level

Management Planning Action Level

Surveillance Actions Action Level